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July 1, 2010

California Energy Commission
Attn: Paul Kramer, Hearing Officer
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512

Re: **Calico Solar Project, Docket No. 08-AFC- 13**

Dear Mr. Kramer,

Please find enclosed for filing the original and one extra copy of the Sierra Club's comments on the proposed Calico Solar Project Staff Assessment and Draft Environmental Impact Statement. Please return a file-endorsed copy in the self-addressed, stamped envelope provided. If you have any questions or need additional information, please contact me at (415) 977-5693 or katie.schaefer@sierraclub.org. Thank you for your attention to this matter.

Sincerely,

Katie Schaefer
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Sierra Club Environmental Law Program
85 Second Street, 2nd Floor
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July 1, 2010

Via Electronic and U.S. Mail

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RE: Sierra Club comments on the proposed Calico Solar Project Staff Assessment and Draft Environmental Impact Statement

On behalf of the Sierra Club, we are writing to provide you with comments on the Staff Assessment and Draft Environmental Impact Statement (SA/DEIS) for the Calico Solar Project (08-AFC-13). The United States Department of the Interior, Bureau of Land Management's (BLM) SA/DEIS is a joint document prepared with the California Energy Commission ("Commission") in order to meet the requirements of the National Environmental Policy Act ("NEPA") and California Environmental Quality Act ("CEQA").

The Sierra Club is the oldest conservation organization in the United States, with over 600,000 members nationwide, and 151,000 members in California alone. Sierra Club is steadfastly committed to preserving the legacy of California's wildlands for future generations, while simultaneously recognizing that climate change has the potential to make radical changes in our habitats and landscapes. Sierra Club is working aggressively to reduce carbon emissions by supporting large scale renewable projects and by quickly ramping up energy efficiency and rooftop solar.

In order to help meet California's and the nation's renewable energy goals, the Sierra Club supports appropriately sited large-scale renewable development, i.e, projects that avoid or greatly minimize environmental impacts to wildlife and plants and the ecosystems they depend upon. For example, there are hundreds of thousands of acres of privately held agricultural lands in California that have marginal productivity or no longer support farming. These lands, with relatively high solarity and poor habitat values, present many opportunities to help meet our goals for large scale solar. The Sierra Club encourages companies and agencies to prioritize these types of lands going forward.

Introduction

The Calico Solar Project ("Project") is proposed for an approximately 8,230 acre site[1] in the Mojave Desert. This large alluvial fan spreads out from the Cady Mountains to the north, covered with sensitive desert flora and fauna. The Project site supports over 7,000 acres of creosote bush scrub, with special status plants such as crucifixion thorn, white-margined beardtongue, Coves' cassia, small-flowered sand verbena small-flowered androstephium, foxtail cactus, Utah vine milkweed, winged cryptantha, and crowned muilla dotting the landscape. Outcrops of black volcanic rock associated with lava flows from the nearby Pisgah crater stand out against the scrub bush, while Mojave fringe-toed lizard run across wind-blown sandy dune habitats. The varied topography and vegetation is especially important to biodiversity at the site; one sees genetic variations in several reptiles and some mammals because of the darker colors of the volcanic rock. SA/DEIS C.2-18. As many as 340 federally "threatened" desert tortoises call this area home, while the native population of Nelson's bighorn sheep forage in the Cady Mountains and use the region as a movement corridor. Golden eagles circle overhead, foraging over the site, while American Badgers and Desert kit fox make use of the desert land for suitable dens. This area is a wonderful example of the beauty and diversity found in high quality, undisturbed desert locations.

The BLM and Commission should not approve the Calico Solar Project in this location. This 850 megawatt (MW) electric-generating facility will

[1] It is not entirely clear if the Applicant's newly proposed reduced acreage alternative is now the new project proposal as no analysis was completed; the Sierra Club is proceeding as though the original project proposal still exists. Additionally, many of the impacts and deficiencies with this project will remain with the newly proposed alternative.

render large portions of high quality habitat a dead zone for threatened and sensitive status species. Unfortunately, there is no appropriate mitigation available for this magnitude of destruction; therefore, this Project represents an untenable proposal for renewable energy.

I. BLM & the Commission's Responsibilities under NEPA & CEQA

The National Environmental Policy Act ("NEPA") is our "basic national charter for the protection of the environment." 40 C.F.R. § 1500.1. Congress enacted NEPA "[t]o declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; [and] to enrich the understanding of the ecological systems and natural resources important to the Nation." 42 U.S.C. § 4321. To accomplish these purposes, NEPA requires all agencies of the federal government to prepare a "detailed statement" that discusses the environmental impacts of, and reasonable alternatives to, all "major Federal actions significantly affecting the quality of the human environment." 42 U.S.C. § 4332(2)(C). This statement is commonly known as an environmental impact statement ("EIS"). *See* 40 C.F.R. Part 1502.

The EIS must "provide full and fair discussion of significant environmental impacts and shall inform decision-makers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment." 40 C.F.R. § 1502.1. This discussion must include an analysis of "direct effects," which are "caused by the action and occur at the same time and place," as well as "indirect effects which . . . are later in time or farther removed in distance, but are still reasonably foreseeable." 40 C.F.R. § 1508.8. An EIS must also consider the cumulative impacts of the proposed federal agency action together with past, present and reasonably foreseeable future actions, including all federal and non-federal activities. 40 C.F.R. § 1508.7. Furthermore, an EIS must "rigorously explore and objectively evaluate all reasonable alternatives" to the proposed project. 40 C.F.R. § 1502.14(a).

The regulations implementing NEPA identify several factors that, when present, indicate that the environmental effects of a proposed action are significant. These include the presence of highly uncertain impacts, impacts to species listed as threatened under the Endangered Species Act, and cumulatively significant impacts. 40 C.F.R. §§ 1508.27(b)(5), (b)(7), (b)(9). This project contains federally listed sensitive species, California special status species, flood hazards, and will have a cumulatively significant impact on the desert environment.

The Commission, as the "lead agency" under CEQA, is responsible for preparing a document to inform the public and decision makers of the projects environmental impacts. Pub. Res. Code § 25519(c), 21080.5. CEQA is designed to fulfill two important goals in the protection of the environment. EIR's (or their functional equivalent) must inform the public and decision makers about all potential, significant environmental effects of a project. Pub. Res. Code § 21100(b)(1). It is necessary to highlight the potential environmental effects "with a sufficient degree of analysis to provide decision-makers with information which enables them to make a decision which intelligently takes account of environmental consequences." 14 Cal. Code Reg. § 15151. An agency must diligently examine these effects and "must use its best efforts to find out and disclose all that it reasonably can." *Id.* § 15144.

This SA/DEIS is legally and technically flawed under both NEPA and CEQA. It fails as an informational document because a vast amount of essential information was omitted, or is not available to the public or key agencies. The Applicant has apparently changed the project footprint, supplemented its Application for Certification, and provided new wildlife and botany surveys to the Commission. This information, however, is not available on the Commission's website. The huge disparity between the information in the SA/DEIS and more recent information provided to the Commission requires the SA/DEIS to be revised and re-circulated. Still, despite the supplemental filings, the environmental analysis is significantly inadequate.

The SA/DEIS also failed under substantive provisions of California law requiring the full mitigation of impacts to threatened species. This project will have serious negative impacts to a wide range of sensitive desert species; as such the SA/DEIS should have contained not only current and accurate scientific information, but also all feasible mitigation measures and reasonable alternatives available. Accordingly, the BLM and the Commission must conclude that the Calico Project will cause significant and irreparable environmental harm and reject the Project. Alternatively, we request that BLM and the Commission fully and completely address the following deficiencies and concerns surrounding the SA/DEIS and re-issue the SA/DEIS for further public comment.

II. The SA/DEIS is Inadequate Because it Lacks Critical Data For Issues that Will Impact the Environment and Defers Information Gathering and Analysis

An overarching and fatal flaw with the SA/DEIS is the omission of relevant critical data throughout. Boiled down, the SA/DEIS omitted disclosure of the full range of potentially significant impacts associated with the Project. Although the SA/DEIS acknowledged these data gaps, it provided no legal reason under NEPA or CEQA as to why these gaps were permitted. The SA/DEIS clearly stated that it is **the Applicant's proposed timeline** that caused the data gaps:

> Because the applicant intends to apply for stimulus funding under the American Recovery and Reinvestment Act (ARRA), and must begin construction by the end of the year to qualify, biological surveys for a variety of species will be conducted concurrently with the review of this document. These survey activities include, but are not limited to, preconstruction surveys for specific resources (i.e., rare plants, nesting birds, desert tortoise, etc.). SA/DEIS C.2-1.

This is inadequate under both NEPA and CEQA. Under NEPA's implementing regulations: "If the incomplete information relevant to reasonably foreseeable significant adverse impacts is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement." 40 C.F.R. § 1502.22. The agency did not claim that this information was cost prohibitive to obtain, and the information that is omitted from the SA/DEIS is certainly "essential to a reasoned choice." 40 C.F.R. § 1502.22(a).

NEPA's implementing regulations make it clear that "NEPA procedures must insure that environmental information is available to public officials and citizens **before decisions are made and before actions are taken. The information must be of high quality**. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA." 40 C.F.R. 1501.1 (emphasis added). CEQA contains similar requirements; public participation is at the heart of CEQA, therefore the public must be able to review and comment on technically accurate and complete EIRs. CEQA requires agencies to inform the public and responsible officials of the environmental consequences of their decisions **before** they are made, thereby protecting the environment and informed self-government. (*Berkeley Keep Jets Over the Bay Com. v. Board of Port Comrs.* (2001) 91 Cal.App.4th 1344, 1354.)

The following are a sample of the acknowledged areas where there is missing data in the SA/DEIS.

- The translocation effort for the desert tortoise is "the critical path for commencement of construction activities." SA/DEIS C.2-6. Yet, the translocation plan is still outstanding. *Id.*

- The Applicant has not completed desert tortoise surveys of the entire project area. SA/DEIS C.2-6.

- The Applicant first characterized the project site as supporting 60-70 desert tortoises (SA/DEIS C.2-63). Staff originally believed there to be at least 100 tortoises on the project site. SA/DEIS C.2-27. Recent studies, however, identify as many as **340** tortoises on the site.

- Information related to translocation of the tortoise, specifically the disease testing limit of 5km, is missing and as such the efficacy of that program can not be assessed. SA/DEIS C.2-7.

- Staff asserts that bighorn sheep move through the project site to access a guzzler in the Cady Mountains, and that this access must remain open; however, no information as to how that will occur is given. SA/DEIS C.2-90.

- No focused bighorn sheep surveys have been conducted, therefore there is little to no information as to the available movement corridors. SA/DEIS C.2-89.

- The Applicant did not conduct wintering bird surveys. SA/DEIS C.2-75.

- A complete survey for golden eagle nesting sites has not been conducted. SA/DEIS C.2-79.

- The Applicant "has not provided specific mitigation to avoid impacts to golden eagles or to mitigate the loss of foraging habitat." SA/DEIS C.2-79.

- The Applicant has not completed a final survey of the number of burrowing owls on the project site, and has not determined their breeding status. SA/DEIS C.2-81.

- The Applicant has not prepared any specific mitigation measures for significant impacts to State waters. SA/DEIS C.2-97.

- Staff noted "many defined drainages," in the project area, but the Applicant has not yet prepared a Streambed Alteration Agreement. SA/DEIS C.2-10.

- Although the Applicant reported on vegetation and habitat found on site, it "did not indicate the vegetation mapping methodology or minimum mapping units." SA/DEIS C.2-13.

- The Applicant also failed to conduct vegetation mapping of the jurisdictional drainages, or botanical surveys of the entire project area. SA/DEIS C.2-6. In fact, according to Staff, there was vegetation present that had not been mapped by the applicant. SA/DEIS C.2-13.

- The Applicant has yet to provide "information necessary to complete development of requirements for dredge and fill in waters of the state." SA/DEIS C.7-2.

- Waste Discharge Requirements have not been developed. SA/DEIS C.7-2.

- Biological Resources Mitigation and Monitoring Plan, Revegetation Plan, Decommissioning Plan, Drainage Erosion and Sedimentation Control Plan, Groundwater Level Monitoring and Reporting Plan, Programmatic Agreement, and other essential Project elements have not been developed due to missing critical data.

These and other omissions and data gaps violate both NEPA and CEQA. The role of an SA/DEIS under NEPA is to provide the public with enough information to adequately assess the environmental dangers of a particular project. Indeed, if reasonably complete information is not included, "neither the agency nor other interested groups and individuals can properly evaluate the severity of the adverse effects." *Robertson v. Methow Valley Citizens Council*, U.S. 332, 352 (1989). Under CEQA, courts have made clear that environmental assessments must provide sufficient information to allow both decision-makers and the public to understand the consequences of the project. *Napa Citizens for Honest Gov't v. Napa County Board of Supervisors*, (2001) Cal.App.4th 342, 356. The information presented in an EIS must be of high quality. 40 C.F.R. § 1500.1(b). "Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA." *Id.* "Agencies shall insure the professional integrity, including scientific integrity, of the decisions and analysis in environmental impact statements." 40 C.F.R. § 1502.24. "They shall identify any methodologies used and shall make explicit reference by footnote to the scientific and other sources relied upon for conclusions in the statement." *Id.* The amount of missing, incomplete, or incorrect data requires the BLM and the Commission to deny the Applicant's proposal, or at the very least, complete the SA/DEIS with all of the necessary information and recirculate for public review and comment.

III. The Analysis of Impacts to Sensitive Animals, Plants, and Other Biological Resources is Inadequate Under NEPA and CEQA

A. The SA/DEIS Inadequately Analyzed Impacts to Sensitive Reptiles

1. Desert Tortoise

The Mojave population of the desert tortoise (*Gopherus agassizii*) was listed as a federally threatened species in 1990. 55 FR 12,178. In California, state laws have been in place since 1939 to protect the desert tortoise. The species was listed as threatened under the California Endangered Species Act in 1989 and is considered a "Species at Risk" under California's Wildlife Action Plan. According to the final federal listing, construction projects and energy development have significantly contributed to the destruction of native habitat. *Id.* Under NEPA, the BLM's SA/DEIS was required to fully disclose all project-related adverse environmental effects which cannot be avoided. 42 U.S.C.S. § 4332(2)(C). The SA/DEIS did not adequately address the Project's impacts on Desert tortoise.

The Project site lies within a broad alluvial plain that drains the Cady Mountains to the north. SA/DEIS C.2-10. Vegetation in the project area is made up of Mojave creosote bush scrub, desert saltbush scrub, and unvegetated habitat, with some smaller patches of vegetation mixed in. SA/DEIS C.2-13. It is known that the "project area supports a broad diversity of wildlife species." SA/DEIS C.2-18. The unique features of the site also increase the biodiversity of the site because some species are habitat specialists, while habitat generalists are wide ranging within the region as a whole. *Id.*

The desert tortoise in and around the Project site are part of the Mojave population, which is primarily found in creosote bush dominated valleys. SA/DEIS C.2-26. The nearest designated critical habitat for the desert tortoise is only half a mile south of the project site. SA/DEIS C.2-27. The 1994 and 2008 Recovery Plans emphasize that activities occurring outside the boundaries of existing tortoise conservation areas can negatively affect tortoise populations. *See* U.S. Fish and Wildlife Service, *Draft revised recovery plan for the Mojave population of the desert tortoise* (*Gopherus agassizii*) at 33 (2008). The 1994 Plan and 2008 Draft Revised Plan recommend that land managers focus recovery efforts toward tortoise conservation areas; however, the Plans also emphasize that land managers should try to **limit the loss of habitat outside conservation areas as much as possible**. *Id.* Here, the proposed project will "result in the direct and permanent loss of approximately 8,230 acres of occupied tortoise habitat." DESI C.2-67.

To determine the amount of desert tortoise that would be directly impacted by the proposed project, the Applicant implemented a modified survey protocol; however, based on the "pace of the survey, staff and CDFG conclude the tempo across the project site . . . would not have allowed the surveyors adequate time to detect all tortoise sign." SA/DEIS C.2-64. The publicly available SA/DEIS states that a **minimum** of at least 100 tortoise or more will be impacted. *Id.* This estimate, however, is nothing more than an educated guess as no reliable surveys have yet been conducted. This does not comport with NEPA requirements that the scientific information contained within an EIS be of high quality. 40 C.F.R. § 1502.24.

According to the SA/DEIS, the Applicant will do a 100% survey to ascertain the number of tortoises that will have to be translocated. Yet this information has not been made available to the public. Apparently, however, the Applicant has conducted another tortoise survey, **with the result that nearly 340 tortoises may be present on the site**. *Applicant's Submittal of Results of 2010 Desert Tortoise Surveys*, at p. 1 (May 17, 2010). This new information must be included in a revised SA/DEIS for public comment because it changes the scope and potential impact immensely. Even when there were estimated to be about 100 tortoises on the site, staff acknowledged that the proposed Conditions of Certification "could themselves result in direct effects such as mortality, injury, or harassment of desert tortoises . . ." SA/DEIS C.2-65. The agencies must provide all new analyses and study results, including new alternatives and mitigation measures, to the public in one document for review and comment.

1. The Project's Mitigation Measures are not Adequate under NEPA or CEQA and Project Effects Can Not be Mitigated

NEPA regulations require that an EIS "include appropriate mitigation measures, not already included in the proposed action or alternatives." 40 C.F.R § 1502.14. Mitigation **includes avoiding the impact** by not taking certain actions, **minimizing impacts by limiting the degree of the action,** fixing the impacts by repairing or restoring the environment, reducing or eliminating impact over time by maintenance and preservation activities during the life of the action, or compensating for the effects by replacing or substituting resources or environments. 40 C.F.R. §1508.20 (emphasis added). Likewise, CEQA requires that the SA describe mitigation measures that are sufficient to minimize the adverse environmental impacts. Pub. Res. Code § 21002.1(a), 21100(b)(3). If there are multiple mitigation measures available, all should be discussed, and the basis for selecting a specific one should be discussed. 14 Cal. Code Regs. § 15370. Here, the proposed mitigation measure is translocation of the desert tortoise. Translocation, however, cannot be thought of as a mitigation measure; rather, it is a salvage mechanism designed to clear the land of tortoises occupying the proposed project site. Some individuals may survive translocation, many will not.

According to the SA/DEIS, "consensus (if not unanimity) exists . . . that translocation is fraught with long-term uncertainties . . . and should not be considered lightly as a management option." SA/DEIS C.2-66. Herpetofauna mortality rates may reach 42%, and recent studies show mortality rates for translocated tortoises may be 25% *per year*. SA/DEIS C.2-65, 66. This study, conducted by Gowan and Berry, shows that of 158 tortoises translocated from the Fort Irwin project, approximately 44% of them have died. Further, an additional 20 tortoises cannot be located.[2] If there are even a minimum of 100 tortoises on the proposed project site, this "mitigation" measure will result in the death of almost 50 threatened desert tortoises. This is unacceptable and cannot be considered mitigation. CEQA specifies that **an agency may not rely on mitigation measures that are of uncertain efficacy or feasibility**. *Kings County Farm Bureau v. City of Hanford*, (1990) 221 Cal.App.3d 692, 727 (groundwater purchase agreement not effective mitigation because there was no evidence that replacement water existed).

Additionally, not only is translocation itself fraught with uncertainty and risk for the tortoises, this SA/DEIS does not even provide information related to the proposed translocation. For example, "specific locations proposed for the translocation areas have not yet been finalized . . ." SA/DEIS C.2-67. **CEQA does not allow deferring the formulation of mitigation measures to post-approval studies**. 14 Cal. Code Regs. § 15126.4(a)(1)(B). The Applicant has not submitted a final Translocation Plan for review by the public; the SA/DEIS tries to avoid this issue by stating that the plan "will be completed by the Spring of 2010." This is insufficient under NEPA and CEQA. *See Sundstrom v. County of Mendocino,* (1980) 202 Cal.App.3d 296, 308-09. Council on Environmental Quality (CEQ) Guidelines make it clear that "agencies shall: (a) Make diligent efforts to involve the public in preparing and implementing their NEPA procedures." 40 C.F.R. § 1506.6. Additionally, NEPA requires all agencies of the Federal government to make "information useful in restoring, maintaining, and enhancing the quality of the environment" (including information on mitigation monitoring of potentially significant adverse environmental

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[2] http://www.scrippsnews.com/content/coyotes-cars-killing-desert-tortoises-moved-fort-irwin

effects) "available to States, counties, municipalities, institutions, and individuals." 42 U.S.C. § 4332(2)(G).

The SA/DEIS admits that the information provided that addresses translocation is insufficient, stating that a "final conclusion [regarding mitigation] can not be reached until the final plan is developed." SA/DEIS C.2-67. BLM is required to disclose mitigation measures in sufficient detail to ensure there has been a fair evaluation of environmental consequences. *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 352 (1989). The agency must take a hard look at these mitigation measures. *See*, *e.g.*, *Neighbors of Cuddy Mtn. v. U.S. Forest Serv.*, 137 F.3d 1372 (9th Cir. 1998). Courts will find an EIS inadequate when it does not adequately analyze mitigation measures or does not analyze mitigation measures it should have analyzed. *See, e.g.*, *Environmental Defense Fund v. Froehlke*, 473 F.2d 346 (8th Cir. 1972) (failure to include land acquisition as a mitigation measure to mitigate the impacts of a channelization project on migratory fowl). Deferring the development of specific mitigation measures, including identifying the land for translocation of the tortoise, has precluded public input on the feasibility of the measures. Without the information related to the translocation plan and translocation sites, the SA/DEIS is legally inadequate.

Further, the SA/DEIS does not discuss the mitigation measures under the required California Endangered Species Act (CESA) "fully mitigated" standard. Under CESA, impacts to a listed species, such as the desert tortoise, must be minimized and **fully mitigated**. CESA § 2081(b), 14 CCR § 783.4. Full mitigation means that no net impacts to listed species may occur under CESA. CESA defines "impacts" that must be minimized and fully mitigated as "all impacts on the species that result from any act that would cause the proposed taking." CESA § 2081(b)(2). Additionally, CESA requires that mitigation measures be "roughly proportional" to the impacts being caused by a project. Id §§ 2052.1 and 2081(b). A risky and scientifically dubious measure such as translocation can not be said to be fully mitigating the impacts to the tortoise caused by this Project, therefore approving this project as currently proposed will result in a violation of the CESA.

Compounding the lack of appropriate mitigation measures is the danger that disease poses to translocated tortoises. Relocating tortoise without disease testing could imperil the health of both the relocated animals and the resident populations into which tortoises will be released. Based on the Berry, et al. (2008), Mack, et al. (2008) and Mack and Berry (2009) reports concluding that disease is not uniformly distributed across geographical areas, it is reasonable to assume that pockets of diseased animals and pockets of healthy animals will occur within the 5 kilometer range of the project site. Failing to fully test animals proposed for relocation could result in the introduction of diseases into otherwise healthy populations. Also, as noted by the CDFG, "moving tortoises *up to* 5 kilometer without disease testing presents risks to other populations." SA/DEIS C.2-57. Not testing the host populations within the 5 kilometer range could result in the introduction of healthy tortoise from the project site into a population that is diseased. Therefore, any translocation should follow the Desert Tortoise Council *Guidelines for Handling Desert Tortoise During Construction*. Moreover, to protect the health of the tortoises, any tortoises moved more than 1000 feet should be fully tested for disease and the host population should be similarly tested

2. Mojave Fringe-toed Lizard

The Mojave fringe-toed lizard is a BLM sensitive species that is found in sandy, hot, sparsely vegetated habitats. SA/DEIS C.2-28. It is restricted to habitats with fine, loose sand. *Id.* Because it is restricted to these sandy locations, and because of increasing development pressures, its habitat has become highly fragmented. *Id.* The habitat fragmentation has in turn left the species vulnerable to local extirpations. It is important to protect the fragile sandy ecosystem upon which the Mojave fringe-toed lizard is dependent. *Id.*

The Applicant originally asserted that out of the over 8,000 acres for the project, only about 16.9 acres had suitable habitat for the Mojave fringe-toed lizard. SA/DEIS C.2-29. Staff, however, believes the Applicant has underestimated the amount of habitat that is available to this species. Staff proposes a mitigation ratio of 5:1, requiring the acquisition and dedication in perpetuity of 84.5 acres of suitable dune habitat. There is no information verifying that this mitigation habitat even exists. The SA/DEIS fails to provide any information addressing potential locations of mitigation habitat. This fails for information purposes under NEPA, and substantive requirements under CEQA. *See Kings County Farm Bureau* 221 Cal.App.3d at 727

In addition to onsite habitat destruction, the SA/DEIS fails to address the potential for the Project to block fluvial and aeolian sand transport to downstream and downwind dunes. This could cause significant offsite impacts to Mojave fringe-toed lizard habitat, resulting in a much larger impact than is examined in the SA/DEIS. The SA/DEIS must be revised and this pertinent information must be provided to the public.

B. The SA/DEIS does not Adequately Address the Impacts to Sensitive Mammals

1. Bighorn Sheep

The population of the Nelson Bighorn Sheep in the Cady Mountains just north of the proposed project location was estimated to be approximately 300 members in 2007. SA/DEIS C.2-33. The SA/DEIS does not contain population numbers for more recent years. In 2010, however, 62 bighorn sheep were observed within 10 miles of the project site. *Id.* Bighorn sheep use approximately 458.3 acres of suitable habitat along the northeast boundary of the project, with an additional 404.5 acres of good habitat located within the project buffer zone. *Id.* Further, the project area overlaps with "the known occupied year-round use area for the Cady Mountains population of at least 300 Nelson's bighorn sheep." SA/DEIS C.2-88. Despite this incomplete data, there were no surveys specific to bighorn sheep completed for the project area and immediate surroundings.

Bighorn sheep have suffered considerable population declines throughout their ranges in the past 140 years. SA/DEIS C.2-90. Roads and other barriers have fragmented their habitat, resulting in lost genetic diversity. *Id.* Loss of water, disease, and other factors have also contributed to their decline. Construction of the project would reduce the availability of seasonal forage and expose the sheep to human disturbance. SA/DEIS C.2-89. Further, the project will likely act as a barrier for movement from the Cady Mountains to the winter ranges of the Bristol Mountains. *Id.*

The SA/DEIS provides almost no information as to how the construction of the project will affect the bighorn sheep, and simply reaches the conclusion that the effects of the project will be less than significant. SA/DEIS C.2-90. Even with the small amount of data provided in the SA/DEIS, this conclusion is not supported. "Bighorn sheep are known to move from the Cady Mountains to winter ranges in the Bristol Mountains in the East." SA/DEIS C.2-88. The only analysis of this information is that "there is a paucity of solid data documenting the movement of sheep in this area." SA/DEIS C.2-89. Even with relocating part of the project perimeter, staff still acknowledged "that human activities may limit use of the site by bighorn sheep." *Id.* This concern is especially important because ewes with lambs are particularly sensitive to disturbance, and ewes with lambs were detected near the project site. *Id.* The SA/DEIS does not go on to analyze this information or suggest mitigation measures to address these facts. Under NEPA and CEQA, an agency must present the public with useful information, (42 U.S.C. § 4332, 14 Cal. Code Regs. §§ 15151, 15144.);

therefore, the incomplete data on the impacts to the bighorn sheep renders the document deficient as a matter of law.

Proposed mitigation for bighorn sheep is also inadequate: only a guzzler is proposed, which may have little or no impact on mitigating impacts such as loss of foraging habitat or blocking migration between the Cady and Bristol Mountains. Clearly a new guzzler alone doesn't mitigate direct, indirect and cumulative impacts to bighorn and habitat connectivity to a level of insignificance. However, absent thorough survey data it is impossible to design mitigation measures for impacts that cannot be estimated.

2. Desert Kit Fox

The desert kit fox is found on the project site. SA/DEIS C.2-90. Although the Applicant has not surveyed for the kit fox, there is suitable habitat on site, and several burrows and scat were observed at the project site. *Id.* The SA/DEIS provides no information as to the number of kit foxes that will be affected. The SA/DEIS does acknowledge that "potential impacts to this species must be avoided" as kit fox is a California protected species. *Id.* Nevertheless, the SA/DEIS provides almost no information as to how the species will be avoided. The only suggestion is that a preconstruction survey should be done, and dens should be flagged. SA/DEIS C.2-91. Once again, this is insufficient under NEPA and CEQA as it provides virtually no scientific information for the public or agencies to use in determining the environmental impact because avoidance measures are not clearly articulated.

C. The SA/DEIS does not Adequately Address Impacts to Sensitive Bird Species

During surveys of the project site, at least 36 different species of bird were documented. SA/DEIS C.2-75. Several of the species identified are California species of special concern or BLM sensitive. Loggerhead shrike, Le Conte's thrasher, Bendire's thrasher, burrowing owl, golden eagle, and Swainson's hawk were all identified. *Id.* The golden eagle is a State fully protected species, and the Swainson's hawk is state listed. Further, although not identified by the Applicant, the prairie falcon likely nests within the Cady Mountains and likely uses the project site for foraging. *Id.*

Unfortunately, the section of the SA/DEIS devoted to bird species is missing data, does not contain a meaningful analysis of effects of the project and potential mitigation measures, and as a whole provides little information for the public to comment on. First, the Applicant did not conduct wintering bird surveys, and did not provide **any** discussion for a variety of species that have a moderate to high potential for occurrence on the project area. SA/DEIS C.2-75.

Loss of active bird nests or young is regulated by the federal Migratory Bird Treaty Act and California Fish and Game Code § 3503. SA/DEIS C.2-76. According to the SA/DEIS, due to the size and extended timeline for the project, "it [is] highly unlikely that nesting birds could be completely avoided if clearing and grubbing occur during the nesting season." SA/DEIS C.2-77. As mitigation, the SA/DEIS proposes 500 foot buffer zones as a mitigation measure, and determines that this will be sufficient to reduce impacts to less than significant *Id.* Directly following this conclusion, however, staff admits that the project will most likely require relocation of active nests. Any relocation must comply with legal requirements under both the MBTA and Fish and Game codes. These requirements are not discussed in depth, and the analysis only states that the Applicant will coordinate with agencies to ensure the work is done properly. *Id.* The SA/DEIS does not provide information as to what types of birds may be affected and how the removal of nests does not increase the impacts to a significant level. Further, staff also proposes allowing variances on the 500 foot buffer but does not provide information related to the types of nests the variances would be granted for or any information related to the maximum number of variances granted. There is virtually no information that would allow the public to make informed comments as to the effects this project will have on many species found on site.

While the SA/DEIS does provide separate analysis for the Swainson's Hawk, golden eagle, and the burrowing owl, these analyses are not sufficient for NEPA or CEQA purposes because they are all missing important data. Without the proper surveys done, the full environmental effects to these birds can not be ascertained. The data gaps in the SA/DEIS are "essential to a reasoned choice." 40 C.F.R. § 1502.22(a), *see also* 14 Cal. Code Regs. § 15151. Additionally, as discussed below, the discussion as it relates to golden eagles is particularly inadequate.

1. Golden Eagle

Golden eagles are a BLM sensitive species and are a fully protected species in California. SA/DEIS C.2-4. The proposed project would remove 8,230 acres of foraging habitat for the species. Although golden eagles were observed by the Applicant in 2007 and 2008, the Applicant did not consider potential impacts to the species and presented no mitigation strategies. SA/DEIS C.2-78. After repeated requests by staff, a helicopter survey was completed. Initial results from this survey show that at least 16 raptor nests were found within a 10 mile radius of the project, two of which contained incubating golden eagles. SA/DEIS C.2-79. However, as the SA/DEIS acknowledges, this is only an initial result, and "as further information regarding potential nest sites becomes available, the data will be incorporated." *Id.* This is inadequate under NEPA and CEQA; without an accurate count of animals potentially affected, the public and agencies cannot determine what the full environmental consequences of the project will be. *See Save our Peninsula Comm., v. Monterey County Bd. of Supervisors*, (2001) 87 Cal.App.4th 99.

There exists an urgent and glaring need for meaningful information. The SA/DEIS was clear that within the foothills of the Cady Mountains, numerous "shallow caves, ledges, and rocky outcrops" were found, all of which provide potential nesting sites. SA/DEIS C.2-79. These sites are all present within 1 mile of the proposed project location. *Id.* Golden eagles are sensitive to human encroachment, and if construction is occurring "when golden eagles are present, these activities may result in the disruption of nest building or the abandonment of existing nest sites." *Id.* The Applicant has not provided specific mitigation plans to avoid impacts to the golden eagle. The lack of complete information related to nesting habitat and specific mitigation measures is another example of the inexcusable data gaps and inadequate "mitigation" plans found throughout the SA/DEIS. This does not meet the legal requirements of NEPA or CEQA.

Additionally, the remainder of the section devoted to golden eagles is likewise inadequate. It appears as though the agencies and the applicant are unsure as to whether the project will even be allowed to go forward if golden eagles are indeed nesting in proximity to the project site. Because the golden eagle is fully protected in California, the Department of Fish and Game will not issue a permit for the direct take of a member of the species. SA/DEIS C.2-80. Federally, the golden eagle is protected under the Bald and Golden Eagle Act.

The Fish and Wildlife Service recently adopted new regulations. 74 FR 46836. Under this statute, all activities that may disturb or **incidentally take an eagle or its nest** must be permitted. *Id.* The definition of disturb "includes interfering with normal breeding, feeding, or sheltering behavior to the degree it causes or **is likely to cause** decreased productivity or nest abandonment." SA/DEIS C.2-80, 72 FR 31132. Large scale solar projects will result in the loss of significant foraging habitat, and this project alone may result in the disruption of nesting golden eagles. The SA/DEIS is clear that the status of golden eagles is uncertain, and therefore permits to "take" are unlikely to be issued. As such, siting this project within an area close enough to golden eagle nests as to disturb them will likely result in a take. The SA/DEIS is unclear as to whether this will effectively require reconfiguration of the project; however, without complete information related to the USFWS's decision on permitting the take of the golden eagle, this entire portion of the SA/DEIS is lacking in any meaningful data. This is precisely the situation that NEPA was designed to protect; the Applicant must provide full survey information related to the golden eagle.

2. Burrowing Owl

As with nearly every other biological resource, the information related to the burrowing owl is insufficient to actually ascertain what the environmental impacts to this species will be. At least two burrowing owls have been detected on site; however, protocol surveys for the species have not been conducted. SA/DEIS C.2-81. Although numerous burrows that are suitable for owls were located on site, the Applicant did not begin surveying for owls until 2010. SA/DEIS C.2-81. Preliminary data shows at least 2 owls on site with 11 active burrows. *Id.* However, "it is not possible to determine their breeding status . . . nor the number of owls that use the site for breeding." *Id.* This is unacceptable under NEPA. 40 C.F.R 1500.1(b). It is impossible to accurately ascertain the environmental effects of this project, when even the number of animals to be affected is unknown. There is no reason provided as to why this survey was not done earlier or at a time when it would have been possible to determine their breeding status. This flies contrary to NEPA and CEQA requirements, namely that information is presented to the public **before** decisions are made. *Id., see also Berkeley Keep Jets Over the Bay Com.* 91 Cal.App.4th 1344.

D. Impacts to Wildlife Movement Corridors are Unacceptably High

Habitat fragmentation is a major concern for conservationists, trustee agencies, and the state and federal governments, especially in view of expected species migration in response to climate change stressors. "Species that cannot adapt in their existing communities may, over time, shift in their ranges if appropriate habitat is available…If they are unable to shift their ranges, they face the threat of local extirpation, if not extinction… Species that have the capacity to shift their ranges will require movement corridors that are not blocked by natural landscape features or human development."[3]. The SA/DEIS acknowledges this, stating "habitat fragmentation and isolation . . . ultimately results in the loss of native species within those communities." SA/DEIS C.2-93. The West Mojave in particular has recently been subjected to multiple instances of habitat fragmentation, all known to affect species such as the bighorn sheep, desert tortoise, kit fox, and Mojave fringe-toed lizard. The project site is a large open space between two highways that is

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[3] California Natural Resources Agency *California Climate Change Adaptation Strategy Discussion Draft* 2009 p 48.

utilized by a large number of sensitive species. *Id.* Specifically, the bighorn sheep forage in the mountainous regions of the project site, and also likely move across the flatlands of the project. These intermountain areas are important for the bighorn sheep to move from one area to another. Indeed, "**intermountainous area of the floor that bighorn traverse between mountain ranges [are] as important to the long term viability of populations as the mountain ranges themselves.**" SA/DEIS C.2-94 (emphasis added). Yet the SA/DEIS failed to provide adequate focused information on habitat connectivity to analyze this significant impact.

The project will also hinder both north-south and east-west movement of the desert tortoise. SA/DEIS C.2-94. The perimeter fencing will result in permanent movement barriers. Little information is provided discussing the effects this permanent limitation will have on the overall health of the species or on their genetic diversity. Even with the mitigation measures proposed, staff concurs that the project will limit movement, **and** nothing will offset the impacts to the north-south corridor. This is a significant burden for the desert tortoise, and as such, the habitat fragmentation of the project should be considered too high to approve.

E. Impacts to Special Status Plants are not Properly Analyzed

The vegetation on the site consists of three primary communities; desert saltbrush scrub, Mojave creosote bush scrub, and unvegetated habitat. SA/DEIS C.2-13. Although the Applicant presented the agencies with a technical report, it "did not indicate the vegetation mapping methodology or minimum mapping units." *Id.* Staff, however, observed numerous smaller patches of vegetation not identified by the Applicant. *Id.* In the central Mojave desert, there are a number of vegetation "communities either known or believed to be of high priority for inventory," but due to the mapping scale used, none of the associations were found on the project site. Staff observations, however, indicate that "any of the special status vegetation types could occur on the site." SA/DEIS C.2-16. Additionally, nine special-status plant species were found on the Project site. SA/DEIS C.2-22. Under section 15380 of the CEQA guidelines plant or animal species may be treated as 'rare or endangered' even if not on one of the official lists if it is likely to become threatened in the near future, and the Commission considers "plants appearing on CNPS List 1B or 2 to meet CEQA's Section 15380 criteria." SA/DEIS C.2-49.

The White-margined Beardtongue is a CNPS List 1B Species and is found on the Project site. The plants on List 1B are rare throughout their range with the majority of them endemic to California. The majority of the species on List 1B have declined significantly over the last 100 years. The plants on List 1B meet the definitions of Sec. 1901, Chapter 10 (Native Plant Protection Act) or Secs. 2062 and 2067 (California Endangered Species Act) of the California Department of Fish and Game Code, and are eligible for state listing. Indeed, the Federal government is currently being petitioned to add the White-margined Beardtongue as a federally-listed endangered species. The White-margined Beardtongue must be fully considered during this SA/DEIS in order to comply with CEQA requirements. Staff concludes that the direct and indirect impacts to vegetation to be significant under CEQA. SA/DEIS C.2-41. We concur. Further, as a state-listed species, any impacts to this plant would have to be fully-mitigated under CESA. *See* CESA § 2081(b).

Although only one List 1B plant was actually found on the site, six other listed species might occur on the site. The SA/DEIS states "[d]ue to limitations of the botanical field surveys described above, staff can not evaluate the total extent of habitat or numbers of the white-margined beardtongue or other List 1B plants within the proposed project area." SA/DEIS C.2-49. This missing information is in violation of NEPA and CEQA; both staff and the public needs to know if a given species is on a proposed site in order to determine the potential environmental significance of the action. Once again, surveys are unlawfully pushed to the "pre-construction" phase, essentially allowing the proposal to be approved with no information as to the true environmental impact the project will cause.

Staff proposes avoidance of the plant species on site as a mitigation measure and concludes that this will work for both the white-margined beardtongue and the Emory's crucifixion thorn because only one occurrence is known within the project site. SA/DEIS C.2-55. However, as discussed above, the surveys were inadequate to determine the actual number of these species on the site. As such, this mitigation measure seems to fail on its face. Further, staff does not know if the measure will work for Coves' cassia or small-flowered sand verbena, because although they were documented on the site, they were not "mapped or inventoried and no analysis of potential project impacts to them were provided by the applicant." *Id.* Without the actual number of listed plants that are going to be affected, the agency cannot conclude that the impacts to the species will be less than significant under CEQA. Proper vegetation surveys must be conducted and included in a supplemental SA/DEIS.

F. Impacts to Waters of the State are Not Adequately Analyzed

The project is located on a large alluvial fan that supports numerous drainages flowing from the Cady Mountains. SA/DEIS C.2-17. The watershed is 43 square miles, and could produce substantial flood flows in a major storm. *Id.* The Applicant originally asserted that there were no waters of the state on the site, but they relied on CRAM methodology which is not suitable for determining jurisdictional status. *Id.* Staff found plentiful drainages with well-defined bank and vegetation indicative of desert washes. SA/DEIS C.2-18. The impacts to at least 258 acres of state waters would be permanent, and would also impact desert wash communities downstream of the project. SA/DEIS C.2-95. Staff properly concludes that "direct and indirect impacts of the project to approximately 1099 acres of State jurisdictional waters to be significant." SA/DEIS C.2-97. The public, and the agencies, have no way to ascertain how these impacts will be mitigated because "the applicant has not yet proposed specific mitigation." *Id.* It is improper for the agency to "expect[…] that the applicant will submit a formal application to the CDFG." *Id.* Under NEPA regulations, this information must be presented "before decisions are made." 40 C.F.R 1501.1(b). As such, the analysis as to impacts to state waters is insufficient.

G. The Cumulative Impacts Analysis is Deficient

A discussion of the cumulative environmental effects of a proposed action is an essential part of the environmental review process, otherwise the agency cannot evaluate the combined environmental effect of related actions. Cumulative impact is defined in NEPA's implementing regulations as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions . . . . Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." 40 C.F.R. § 1508.7

Under NEPA, an EIS must provide a sufficiently detailed catalogue of past, present, and reasonably foreseeable future projects, and provide an adequate analysis of how these projects, in conjunction with the proposed action, are thought to have impacted or are expected to impact the environment. *See Muckleshoot Indian Tribe v. United States Forest Serv.*, (9th Cir.1999) 177 F.3d 800, 810 (per curiam) (quoting 40 C.F.R. § 1508.7). In addition to an adequate cataloging of past projects, NEPA also requires a discussion of consequences of those projects. However, the SA/DEIS fails to properly assess and address the severe cumulative biological and other impacts of the project.

Considered in the context of other proposed large energy projects in the region, the cumulative impacts of the Project are significant in nearly every issue category. On a human time scale, these cumulative impacts will be pervasive, causing landscape-level biological, cultural, visual and other impacts that will be permanent or last hundreds of years after the expected lifetime of the Project. The SA/DEIS fails to provide adequate analysis, identification, and mitigation or avoidance of Project cumulative impacts.

For example, the SA/DEIS found that cumulative impacts to rare and sensitive species such as desert kit fox and American badger would be severe and the Project's contribution to their decline would be significant without mitigation. SA/DEIS C.2-142. But without adequate foundation, the analysis simply concluded that cumulative Project impacts to these species would be minimized to a level less than significant by avoidance and minimization measures in proposed Conditions of Certification. SA/DEIS C.2-147. However, the extent of cumulative impacts to these species has not been identified, and the mitigations proposed are acquisition of *tortoise* habitat, future Project surveys and identification of burrows and relocation of individual kit fox or badgers where feasible. SA/DEIS C.2-195 Like tortoise relocation, this "mitigation" is simply a salvage operation of unproven success. Further, the proposed habitat compensation simply "piggy-backs" on tortoise compensation lands, which are not required to be appropriate habitat for, or to have adequate carrying capacity for, identified severe cumulative impacts to desert kit fox and American badger.

Inter alia, the SA/DEIS fails to provide an adequate analysis of how these related projects, in conjunction with the proposed action, are thought to have impacted or are expected to impact the environment. The acreages and intent of the identified related projects are given, but actual cumulative impacts of these projects on the affected environment are not analyzed in adequate specificity. In particular, the cumulative biological context is deficient. The SA/DEIS fails to analyze the threshold questions about the cumulative context: What is the existing condition for the species at risk? What is the expected future condition for the species and biological processes at risk from the cumulative impacts of this and other existing and reasonably foreseeable actions? And what relative contribution to these impacts is the proposed project expected to make?

The cumulative impacts analysis, and the biological analysis on which it relies, provide scant analysis of the current condition of the species, the condition of the primary constituent elements of habitat necessary their survival, how existing and foreseeable projects affect the species and its habitat, and how the project will contribute to this condition. The SA/DEIS primarily relies on raw acreage information for its assessment of cumulative impacts. Critical factors that affect the ability of habitat to support species, such as existing and foreseeable fragmentation, edge effects, habitat connectivity, relationship to migration corridors needed for climate change adaptation, and other essential parameters were given scant analysis, leaving the reviewer with little understanding of the Project's real cumulative import. In so doing, the cumulative analysis also relies on the

SA/DEIS's deficient biological resources analysis for the proposition that cumulative impacts are mitigated, partially or wholly.

Even where raw acreages are somewhat reliable parameters, the SA/DEIS's cumulative analysis is faulty. For instance, with regard to the project's cumulative impacts to watershed streams, the SA/DEIS finds the cumulative effects to the Newberry Springs watershed streams from future projects to be significant (14%), with the Project's contribution nearly half (45%) of those impacts. SA/DEIS 3.2-129. The SA/DEIS claims to mitigate impacts to washes to less than significant by Condition of Certification BIO-27. SA/DEIS C.2-129. However, the proposed condition only requires that 436 acres of habitat be acquired to compensate for the 1000 acres of State jurisdictional waters onsite. SA/DEIS C.2-197. Additional mitigation which would require a more adequate compensation ratio is dependent on deferred surveys and a deferred Management Plan for the acquired compensation lands. SA/DEIS C.2-197. Additionally, the Project's impacts to the washes captured within the Project's deeply incised northern boundary and washes displaced along the Project's other boundaries are not accounted for in the acres of jurisdictional washes affected. SA/DEIS Biological Resources Figure 3.

Compounding the deficiencies in the cumulative analysis is the fact that (as outlined above) the biological assessment is severely lacking in basic data. It also contains no cumulative thresholds of significance,[4] and is significantly deficient in purported mitigation (which usually consists of future surveys, yet-to-be-formulated plans, and/or future monitoring and adaptive management, for which the necessary funding has yet to be determined or secured).

Even the SA/DEIS found that "there may be cumulative effects remaining even after mitigation is implemented by all projects," SA/DEIS C.2-150, and "[l]oss or fragmentation of habitat, displacement, disruption of movement if these species occur in project area." SA/DEIS C.2-39. However, here again, the reader needs a context to understand the full extent and relative importance of the impact, and this the SA/DEIS fails to provide. Instead, the SA/DEIS notes that these residual cumulative effects "could be addressed through a regional and coordinated planning effort aimed at preserving and enhancing large, intact expanses of wildlife habitat and linkages, including maintaining connections between wildlife management areas and other movement corridors" and that "ongoing collaborative efforts

[4] Based on climate change scenarios, the Department of Fish and Game should work to develop thresholds of significance for the adaptive capacity of species related to any direct, indirect and cumulative impacts of projects. *California Climate Change Adaption Strategy*. 2009, 61.

by federal and State agencies to develop a Desert Renewable Energy Conservation Plan and BLM's Solar Energy Development Programmatic EIS offer an appropriate forum for such planning." SA/DEIS C.2-150.

Further, the analysis relies on an artificially limited subset of foreseeable future projects. Most courts have found that an EIS must address all "reasonably foreseeable" future actions that have potential cumulative impacts. *See*, *e.g.*, *Blue Mountain Biodiversity Project v. Blackwood*, 161 F.3d 1208 (9th Cir. 1998). The SA/DEIS states that "[t]he acreage figure used for the cumulative biological impacts assessment '[i]ncludes only BLM Renewables that had submitted a Plan of Development (POD) at the time of the analysis and those additional future projects listed in Biological Resources Table 6 C.2-131ff. This limited definition of a reasonably foreseeable future action may improperly limit the scope of review.

Clearly, the SA/DEIS has not assembled enough information and performed the requisite analysis (and the responsible agencies do not have adequate planning guidance) to determine: 1) the level of cumulative impacts to habitats, species and ecosystems, especially in the context of likely climate-change-necessitated habitat and species migration, or: 2) the limits of acceptable change; 3) how to avoid significant cumulative impacts that would foreclose future opportunities to sustain desert ecosystems and species. This is a violation not only of NEPA and CEQA, but of State and Federal mandates requiring sustainable resource protection, such as FLPMA and the 2009 California Climate Change Adaptation Strategy (herein incorporated by reference). The latter stated, "In the face of a changing climate it is imperative that Departments work to maintain healthy, connected, genetically diverse populations" to "aid[] the movement of species within reserve areas as they adjust to changing conditions associated with climate change." 2009 California Climate Change Adaption Strategy, 56. This guidance document also directed California Department of Fish and Game to ensure that CEQA review addressed climate change issues in this context.[5]

As a thorough cumulative impact analysis is required for public and the agencies to make an informed decision regarding the consequences of a proposed action, the SA/DEIS must be revised to thoroughly examine the above-referenced deficiencies.

[5] CEQA Review/Department Guidance – The Department of Fish and Game will initiate the development of internal guidance for staff to help address climate adaptation and to ensure climate change impacts are appropriately addressed in CEQA documents. Id. 61.

H. The SA/DEIS Fails to Address Climate Change Adaptation

Although the ostensible goal of the project is to help ramp up renewable energy and thereby contribute to the reduction of GHG emissions, CEQA mandates that the responsible agencies also consider what effect the project will have on climate change adaptation for habitats and species. CEQA Guidelines § 15126.2. As outlined under Cumulative Impacts, the SA/DEIS has failed to do so.

I. The SA/DEIS is Inadequate Under NEPA Because it Fails to Properly Analyze the Connected Action of Upgrading and Expanding Transmission Lines

Under NEPA, an agency may not divide a project into multiple "actions," each of which individually has an insignificant environmental impact, but which collectively have a substantial impact. 42 U.S.C. § 4332; 40 C.F.R. § 1508.25. Here, the SA/DEIS states that the "SCE upgrades are a reasonably foreseeable event if the Calico Solar Project is approved and constructed as proposed," yet goes on to state that the "projects will be fully evaluated in a future EIR/EIS." SA/DEIS C.2-113. This is an improper segmenting of a connected action and rendered the SA/DEIS inadequate under NEPA.

NEPA "requires a federal agency to prepare an EIS for all 'major Federal actions significantly affecting the quality of the human environment.'" *Wetlands Action Network v. U.S. Army Corps of Eng'rs*, 222 F.3d 1105, 1115 (9th Cir.2000), quoting 42 U.S.C. § 4332(2)(C). The CEQ regulations relating to an EIS require:

> The scope of an individual statement may depend on its relationships to other statements. To determine the scope of environmental impact statements, agencies shall consider 3 types of actions, 3 types of alternatives, and 3 types of impacts. They include:
>
> (a) Actions (other than unconnected single actions) which may be:
>
> (1) Connected actions, which means that they are closely related and therefore should be discussed in the same impact statement. Actions are connected if they:
>
> (i) Automatically trigger other actions which may require environmental impact statements.

(ii) Cannot or will not proceed unless other actions are taken previously or simultaneously.

(iii) Are interdependent parts of a larger action and depend on the larger action for their justification.

40 C.F.R. § 1508.25 (citations omitted) (emphasis added). The purpose of this requirement is "to prevent an agency from dividing a project into multiple 'actions,' each of which individually has an insignificant environmental impact, but which collectively have a substantial impact." *Wetlands Action Network*, 222 F.3d at 1118 (internal quotations and citation omitted).

Courts apply an "independent utility" test to determine whether multiple actions are so connected as to mandate consideration in a single EIS. The crux of the test is whether "each of two projects would have taken place with or without the other and thus had 'independent utility.'" *Wetlands Action Network*, 222 F.3d at 1118 (internal quotations and citation omitted). Here, the SA/DEIS acknowledges that the new transmission lines and upgrades are "to support the operation of the full Calico Solar Project," and that there are "potential environmental public health effects that may result from other actions related to the Calico Solar Project." SA/DEIS C.2-113. Further, without the upgrade to the transmission lines, the Project would become virtually useless as the power generated would not be able to be transported anywhere. Thus, the upgrades and expansion of the transmission lines fail the "independent utility" test. *See Thomas v. Peterson,* (9th Cir. 1985) 753 F.2d 754, 759 (where court concluded that the construction of a road in a forest and the sale of timber were connected actions within the meaning of the CEQ regulations. Because the timber sales could not proceed without the road, and the road would not have been built but for the timber sales, the two were "inextricably intertwined.").

Further, the environmental consequences of this connected action are significant. Eleven species of reptile, including the threatened desert tortoise and ten special status plants, including the BLM Sensitive Species short-joint beavertail cactus and the white-margined beardtongue were identified in the Pisgah Lugo corridor. SA/DEIS C.2-115, 116. Portions of the project corridor would cross 533 acres of critical habitat for the desert tortoise. SA/DEIS C.2-116. The corridor also would pass through areas covered by the West Mojave Management Plan. Under the Plan, take of the white-margined beardtongue is limited to 50 acres; however, "it's not clear whether the SCE upgrades to the Pisgah to Lugo transmission line would comply with these requirements of the Plan as currently proposed." SA/DEIS C.2-117. Staff concludes that the SCE upgrades "may create significant impacts to biological resources due to the permanent loss of habitat and the disturbance to sensitive plant and wildlife species during construction." SA/DEIS C.2-122. Considering the potentially large scope of the environmental impacts of the transmission lines, and the fact that they are a "reasonably foreseeable event if the . . . Project is approved," the SA/DEIS was required to consider the upgrades as a connected action. As a connected action, the information presented in the SA/DEIS must be accurate and high-quality, as per NEPA regulations.

IV. The Alternatives Analysis is Inadequate Because BLM Unlawfully Rejected Feasible Alternatives

a. BLM's Statement(s) of Purpose and Need Reflects the Applicant's Needs and Is Too Narrowly Drawn.

The Alternatives Analysis "is the heart of the environmental impact statement."[6] CEQ regulations require that an alternatives analysis presents the environmental impacts of the proposal and the alternatives in comparative form, sharply defining issues and providing a clear basis for choice among options by the decision-maker and the public. 43 CFR § 1502.14. In the SA/DEIS Alternatives Analysis, BLM did not consider the Private Land and other private offsite alternatives under NEPA on the basis that these alternatives would not accomplish the purpose and need of the proposed action. [7]

The decision not to examine these alternatives was incorrect because BLM's statement of purpose and need for the SA/DEIS is too narrowly drawn. Courts have held that although an agency has discretion to define the purpose and need of a project, it cannot use "unreasonably narrow" terms to define a project's objective. The Department of Interior ("DOI") regulation, 40 C.F.R. § 1502.13 merely requires that an EIS briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action. DOI's NEPA handbook explains that the "purpose and need statement for an externally generated action must describe the BLM purpose and need, **not an applicant's or external proponent's purpose and need.** " Department of Interior, Bureau of Land Management, National Environmental Policy Act Handbook 35 (citing 40 C.F.R. § 1502.13) (emphasis added).

Here, however, in contravention of NEPA guidelines, the BLM only looked to the Applicant's purpose and need. The SA/DEIS stated that the

[6] 40 C.F.R. § 1502.14.

[7] "[S]ince the proposed actions under review in this document are whether to approve or deny, or approve with modification an application for the Calico Solar project to be sited on public land, analysis of a private land alternative would not be consistent with the stated purpose and need of the proposal." SA/DEIS B.2-18.

purpose and need is "to respond to Calico Solar, LLC's application under Title V of FLPMA, 43 U.S.C. § 1761, for a ROW grant to construct, operate, and decommission a solar thermal facility on public lands in compliance with FLPMA, BLM ROW regulations, and other Federal applicable laws." Based on this narrow statement of purpose and need, BLM has declined to examine any private land off-site alternatives (as well as dismissing alternative technologies, distributed generation, energy efficiency and demand response). In so doing, BLM impermissibly rejected reasonable alternatives on the basis of inconsistency with the applicant's purpose and need. Moreover, BLM did so in spite of numerous scoping comments requesting consideration of a private/disturbed land alternative[8] as well as alternative methods to meet agency goals to ramp up renewable generation and/or reduce reliance on non-renewable fuels.[9]

As the Energy Policy Act, and related Secretarial and Executive Orders direct BLM to "encourage the development of environmentally responsible renewable energy" while complying with existing environmental laws, the project purpose and need statement need not be so narrowly drawn as to preclude the consideration of alternative locations and technologies. To do so reflects the needs of the project applicant, not the needs of BLM, in violation of NEPA. In fact, an agency's refusal to consider an alternative that would require some action beyond that of its congressional authorization is counter to NEPA's intent to provide options for agencies. *See* 40 C.F.R. 1502.14. BLM's decision to narrow its purpose and need to preclude the analysis of alternative sites, and to avoid analysis of offsite alternatives because they are outside of its jurisdiction, renders the SA/DEIS deficient.

b. The SA/DEIS Rejected Distributed Generation, Energy Efficiency and Demand Response Without Adequate Information and Analysis

The Sierra Club recognizes that in order to begin achieving climate change goals, and ramp up renewable energy generation quickly in the near term, some large utility scale solar generation will be necessary. The Sierra Club supports this, if done without causing irreparable harm to sensitive and irreplaceable resources. However, the future potential for distributed generation, energy efficiency and demand response is significant over time, and in the near term much can be achieved with proper policy support. Moreover, it is entirely feasible that, over time, these alternatives could become the primary method to both meet State Renewable Portfolio

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[8] "Scoping comments requested disturbed private land alternatives, stating that because the Stirling technology is developed in clusters, it is not necessary for the solar facility site to be on a single contiguous parcel." SA/DEIS B.2-18.

[9] EPA comments, p. A-20.

Standards (RPS) goals and achieve important climate change goals.[10] In the meantime, these alternatives, if actions go beyond and do not supplant existing planned distributed generation and energy efficiency measures, are certainly capable of meeting the equivalent of 850MW of renewable energy generation in the expected 58 months (nearly five years) to bring this proposed Project fully online.[11] So although a significant amount of large scale renewable energy (including solar thermal and PV, wind, and geothermal) must be sited to achieve our climate goals, no one large-scale solar project is indispensable. In certain cases where environmental conflicts in a particular proposed project are high, the alternatives of distributed generation, energy efficiency and demand response should be given full consideration as a means to meet climate goals in lieu of a particularly egregious project or a portion thereof that causes severe unmitigable environmental impacts.

In its rejection of these alternatives, the SA/DEIS asserts they are not required to be analyzed by the BLM because they fall outside BLM's purpose and need for the proposed action. Here again, BLM impermissibly rejects a project alternative based solely on its unlawfully narrow purpose and need statement.

Additionally, the SA/DEIS opines without foundation that achieving 850 MW of distributed solar PV or distributed solar thermal would "depend on additional policy support*, manufacturing capacity, and lower cost* than currently exists to provide the renewable energy required to meet the California Renewable Portfolio Standard requirements" Alternatives Table 1, SA/DEIS B.2-3ff (emphasis added). However, the SA/DEIS analysis of the distributed generation alternative and its potential to help meet the California Renewable Net Short is erroneous, conclusory, and not supported by substantial evidence in the record.

Recently, a presentation by Black & Veatch, the consultants for the Commission's own Renewable Energy Transmission Initiative ("RETI"), reported to CPUC regarding current distributed generation potential. Using GIS, Black & Veatch identified sites for ground-mounted PV and large commercial rooftops within 3 miles of distribution substations, and reported a

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[10] *Black and Veatch, Summary of PV Potential Assessment in RETI and the 33% Implementation Analysis*, December, 2009. Attach excel spreadsheet of PV deployment.

[11] In its rejection of distributed generation as an alternative to the project, the SA/DEIS improperly found that "while it will very likely be possible to achieve 850 MW of distributed solar energy over the coming years, the very limited numbers of existing facilities make it difficult to conclude with confidence that it will happen within the timeframe required for the Calico Solar Project." SA/DEIS B.2-68, 69. "The Calico Solar Project would be developed in two phases. The schedule would be approximately 58 months in duration. SA/DEIS C.2-19

wholesale distributed generation potential of 17,300 MW [12] with no upgrades required.[13] These figures indicate that larger scale distributed solar generation can provide a substantial portion of the 2020 RPS "Net Short," and probably more than that.[14]

The SA/DEIS also asserts that distributed PV must achieve lower costs to be competitive. Alternatives Table 1, SA/DEIS B.2-3ff However, RETI ascertained that PV is more cost-effective than solar trough at current thin-film PV pricing of $3,700/kW a/c[15], and SCE has committed to CPUC that its distributed commercial rooftop program in Ontario, CA will cost $3.50/watt d/c,[16] or less than $4,000/kWa/c. If the SA/DEIS asserts that distributed generation should not be considered because it is too costly, then it should provide Project costs, including operations, maintenance, plus transmission costs and losses for comparison.

Finally, the SA/DEIS rejection of distributed generation asserts it would be infeasible to ramp up 850 MW of distributed renewable energy within the time frame for the Calico project, which is 58 months, or roughly 5 years. SA/DEIS C.2-19 However, tens of thousands of MW of PV are being manufactured each year,[17] and worldwide PV production capacity substantially exceeds current worldwide demand.[18] Additionally, distributed PV can come on line quickly.[19] At any reasonable growth rate, even those far below current and historical levels, distributed PV can meet RPS goals

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[12] This value is conservatively based on using only one-third of the actual potential capacity (52,000 MW), for reasons that are not explained. *Black and Veatch, Summary of PV Potential Assessment in RETI and the 33% Implementation Analysis*, December, 2009.

[13] Data on the PV capacity of existing substations provided to the California Public Utilities Commission by investor-owned utilities indicates that these substations can accept approximately 20,000 MW of distributed PV with no upgrades required to the substations.

[14] The studies cited above show an estimated distributed solar generation capacity by 2020 of between 25,000 and 50,000 MW, which corresponds to an electrical energy potential of 50,000 to 100,000 GWh/yr. *Black and Veatch, Summary of PV Potential Assessment in RETI and the 33% Implementation Analysis*, December, 2009.

[15]RETI Phase 2B Final Report.

[16] CPUC Proceedings, SCE Solar Roof Program, June 2009.

[17] Estimated worldwide thin-film PV production capacity at the end of 2009 was approximately 7,400 MW.Schreiber, D., EuPD Research, *PV Thin-film Markets, Manufacturers, Margins*, presentation at 1st Thin-Film Summit, San Francisco, December 1-2, 2008. Estimated worldwide conventional polycrystalline silicon PV production capacity reached 13,300 MW per year in 2008, and it is projected to reach 20,000 MW per year in 2010. Schreiber, D., EuPD Research, *PV Thin-film Markets, Manufacturers, Margins*, presentation at 1st Thin-Film Summit, San Francisco, December 1-2, 2008.

[18] The current estimated oversupply of PV panel manufacturing capacity for 2010 is 8,000 MW B. Murphy, Fulcrum Technologies, Inc., *The Power and Potential of CdTe (thin-film) PV*, presented at 2nd Thin-Film Summit, San Francisco, December 1-2, 2009.

[19] "Because these installations will interconnect at the distribution level, they can be brought on line relatively quickly without the need to plan, permit, and construct the transmission lines." CPUC, SCE Application for 500MW Urban PV Project,

timely.[20] And since distributed PV is sited in developed areas, it can do so while avoiding virtually all biological impacts to sensitive desert resources and other unmitigable significant impacts of the Project. SA/DEIS B.2-67.

Similarly, the SA/DEIS summarily dismissed the conservation/demand side management alternative (energy efficiency) without adequate foundation, stating that: "Conservation and demand-management *alone* are not sufficient to address all of California's energy needs" SA/DEIS B.2-6 (emphasis added). This is self evident, but it does not speak to the issue. The issue is: if necessary to avoid irreparable harm to irreplaceable resources, could energy efficiency allow the Project to be modified or denied, and still allow the responsible agencies to meet their respective climate change objectives?

The answer is yes. Energy efficiency has been forecast to achieve an enormous reduction in electrical energy use. There is a huge potential to achieve "negawatts" through building retrofits, improved building codes, and other measures in California; and current utility programs to support energy efficiency could be greatly expanded, likely at a significantly lower cost to consumers than most forms of energy generation. California Air Resources Board adopted a savings target of 32,000 gigawatt-hours above and beyond what the CEC has forecast, and adopted a target of 30,000 gigawatt-hours generated from new on-site combined heat and power (CHP) by 2020.[21] Sierra Club supports this goal, but even if it were not fully realized, it would make a significant contribution by reducing greenhouse gases as well as the net short needed to meet RPS goals.

Thus, the potential of energy efficiency and distributed generation is significant (alone or in combination), even beyond current targets; and efficiency in particular is more than cost competitive. The feasibility of replacing the Project's objective of 850MW in five years should be reviewed in light of the multiple environmental impacts of this Project. [22] Accordingly, the responsible agencies have an affirmative duty to fully consider conservation and demand side management as a feasible alternative to reduce a project (and therefore its output) in order to avoid severe unmitigable impacts, or even as a full alternative to an exceptionally impactful project.

[20] See attached spreadsheet modeling solar PV growth at varying rates

[21] California Air Resources Board, Climate Change Scoping Plan, 2008 p 63

[22] At full build-out and if operating at 99% efficiency, the Project is expected to generate 1840 gigawatt-hours a year. SA/DEIS C.1-71.

c. **The Analysis of Alternative Sites and Alternative Energy Solutions Violates NEPA, and CEQ Guidelines**

The second rationale asserted for dismissing the Private Land Alternative was that "analysis of such an alternative, over which BLM has no discretionary approval authority, would not present impacts in a form that would define issues or provide a basis for choice in a manner any different than the no action alternative." SA/DEIS B.2-18. The SA/DEIS fails to inform the reviewer how the BLM would be unable to analyze impacts of the Private Land Alternative -- impacts which the SA/DEIS identifies as being less adverse in most cases than the proposed project, by an order of magnitude, as explained below.

The SA/DEIS position on this matter directly conflicts with CEQ regulations to "[i]nclude reasonable alternatives not within the jurisdiction of the lead agency." 40 C.F.R. 1502.14(c). The SA/DEIS even acknowledges that "[w]hile a project to be located on private land is not within the approval jurisdiction of the BLM as lead agency, if otherwise reasonable, **it is still required to be analyzed by the BLM**." SA/DEIS B.2-18 (emphasis added). After reaching this conclusion, however, the SA/DEIS does **not** proceed to properly analyze a Private Lands Alternative.

The SA/DEIS asserted that the Reduced Acreage Alternative and Avoidance of Donated and Acquired Lands Alternative would substantially reduce impacts in comparison to the proposed project. SA/DEIS B.2-84. After concluding that these alternatives would meet the project objectives, Staff improperly dismissed them "because they would reduce the generation capacity, [and] may not attain the purpose and need for the project." SA/DEIS B.2-84 Additionally, BLM considered, but dismissed from further evaluation without adequate substantial information and analysis, alternative renewable technologies, and the alternatives of distributed renewable energy generation, energy efficiency and demand response. In violation of NEPA, BLM only analyzed reduced project and "no project" alternatives in the SA/DEIS. Again, BLM's use of an impermissibly narrow purpose and need statement confounds the entire Alternatives Analysis, and leads the public to believe that there is a pre-decisional bias towards siting the Project at this location.

d. **Relocation to the Analyzed Private Land Site or Cadiz Land Company Disturbed Lands Would Reduce the Project's Impacts**

Although grossly deficient in other ways, the SA/DEIS's Biological Assessment does call out the project site's virtually undisturbed state, its environmentally sensitive resources and location, and its exceptional freedom from substantial man made alteration.[23] In stark contrast to the high value project site, the SA/DEIS finds that the Private Land Alternative might avoid all impacts to sensitive species. Staff states "[g]iven that most of this [the Private Land] alternative (approximately 50%) is agricultural land, disturbed habitat, and developed land, it may be possible to site facilities such that most or all of the sensitive biological resources on site would be avoided." SA/DEIS B.2-32. It goes on to correctly identify the Private Land Alternative as environmentally preferred over the proposed project. SA/DEIS B.2-32.

It is clear that the Private Land Alternative (or for that matter, disturbed private land use alternatives) would greatly lessen the project's significant impacts, including destruction of vast amounts of desert wash resources[24] as well as habitat and habitat connectivity for desert tortoise, bighorn sheep and other sensitive, threatened and endangered species. Accordingly, it is impermissible for BLM to reject the Private Land alternative from consideration on the basis of a flawed statement of purpose and need statement and without substantive evidence to support their position. SA/DEIS B.2-18. In fact, it constitutes a violation of BLM's mandate to "take any action necessary to prevent unnecessary or undue degradation of the lands." 43 U.S.C § 1732(b).

Additionally, the SA/DEIS has failed to identify and analyze an even more feasible private land alternative site. Pursuant to CEQ regulations, all reasonable alternatives must be examined. Here, a feasible alternative exists that was not discussed, and one that does not have the feasibility concerns related to aggregating numerous landowners for site acquisition. It is the tens of thousands of acres of Cadiz Land Company land, which was publicly noticed as available for solar development in 2009[25]. Much of this land is type converted; it is also in the Mojave desert of California, has excellent insolation, and is near existing transmission. The SA/DEIS had no valid reason to exclude consideration of this very viable alternative to the problematic Calico project site. NEPA and CEQA mandate that these environmentally preferable Private Land alternatives should be properly analyzed and adopted.

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[23] "most of the project area is distant from these features and relatively undisturbed by the threats listed above. There appears to have been little habitat damage by grazing, cross-country ORVs, or weed invasions" … "Staff notes that the habitat in the project area is generally undisturbed. Invasive weeds occur in disturbed soils such as roadsides throughout the area, but have not substantially altered native vegetation and habitat as they have elsewhere in the Mojave Desert." SA/DEIS C.2-47-48.

[24] The project will cause nearly 42% of the future cumulative impacts to stream wash resources in the Newberry Springs cumulative impacts geographic study Area. (Biological Resources Figure 3)

[25] http://www.cadizinc.com/blog/2009/press-release-cadiz-signs-green-compact-natural-heritage-institute/index.html.

e. The SA/DEIS Impermissibly Limits Agency Authority to Adopt an Environmentally Preferable Alternative

Even though the analysis showed that the Private Land Alternative would be preferred to the proposed Calico Solar Project site for biological resources, cultural resources, visual resources, and potentially transmission system engineering, SA/DEIS B.2-50, the SA/DEIS found that approval of a private land alternative would be "remote and speculative" if no application is pending, and that "The Energy Commission does not have the authority to approve an alternative or require Calico Solar to move the proposed project to another location, even if it identifies an alternative site that meets the project objectives and avoids or substantially lessens one or more of the significant adverse effects of the project because it would require a new Application for Certification ("AFC") and environmental review might reveal more impacts."(B.2-19)

But the underlying concern is articulated: "Preparation and review of a new AFC for the Calico Solar Project on an alternative site would require substantial additional time." SA/DEIS B.2-19. The lack of an application to develop an alternative site or an artificially constricted time frame for project approval are not recognized under CEQA as justification to reject an otherwise feasible and environmentally preferred alternative.[26] Here again, in rushing to meet the arbitrary ARRA funding deadline, the responsible agency is sidestepping its responsibility under the law to analyze and adopt the most environmentally preferred feasible alternative. The Recovery Act website states that "[i]f new information arises late in the process, analyses may have to be redone, significantly affecting the schedule."[27] This shows, contrary to the applicant's and agencies' assertion, that environmental regulations such as NEPA and CEQA must be complied with; application for stimulus funding does not allow a project to sidestep valuable environmental regulations.

f. The Analysis of the Donated Lands Alternative is Inadequate and Contains Serious Policy Implications that Should Be Addressed

With regard to Land Use, the SA/DEIS acknowledges that in the Project would violate an "interim" policy promulgated by the BLM State Director which requires LWCF lands to be managed as avoidance/exclusion areas for land use authorizations that could result in surface disturbing activities (BLM 2009a). But what the SA/DEIS fails to acknowledge is that the specific donated lands involved in the Project, were Catellus lands

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[26]https://recoveryclearinghouse.energy.gov/#NATIONAL_ENVIRONMENTAL_POLICY_ACT_NEPA.
[27] *Id.*

acquired and donated to BLM as part of a $45 million private gift, and were accepted for "permanent preservation" [28] and "being preserved for future generations"[29] by the highest levels of government. Additionally, the White House assured the public that "[o]nce acquired the lands would be open to public access for outdoor recreation, including hiking, hunting and other permitted uses." [30] Please see attached letter from President Clinton, News Release from the White House, and correspondence from Bruce Babbitt, Secretary of the Interior, all in office at the time of the donation.

The commitment to preservation of and public use of the donated Catellus lands which was asserted at the highest levels of government goes far beyond the SA/DEIS's characterization of an "interim" state BLM policy. The industrialization of these donated lands must be analyzed and weighed in light of the assurances given by the federal government. This issue has serious implications for future land conservation in the US.

V. The SA/DEIS is Inadequate Because the Cultural Impacts Analysis is Unlawfully Deferred

The Project could have significant cultural impacts and would "wholly or partially destroy all archeological sites on the surface of the project area." SA/DEIS C.3-113.[31] The discussion of impacts to cultural resources is incomplete and inadequate. Assessment of the short and long term adverse impacts to cultural resources will be completed only in the "Programmatic Agreement currently under development." SA/DEIS ES-20.

The Project would have significant impacts on an unknown subset of 401 surface prehistoric and historical surface archaeological resources identified in the survey of 25% the project, SA/DEIS C.3-1, and "may have significant impacts on an unknown number" of surface and buried archaeological deposits on the remaining 75% of the project, many of which may be determined historically significant. SA/DEIS ES-20. The project may also have indirect cultural impacts, because the Desert Bighorn Sheep and other animal species have cultural significance to Native Americans, and as acknowledged by the SA/DEIS, Desert Bighorn and other species would be adversely affected by the project. Indirect cultural impacts would also result from the Project's aesthetic impacts on the culturally significant Pisgah Crater area; in fact, Native American representatives requested a site visit to identify important traditional

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[28] Letter from President Clinton to David Myers, Wildlands Conservancy dated May 10, 2000
[29] Office of the White House News Release, *Vice President Gore Announces New Land Protections in the California Desert,* May 18, 2000
[30] *Ibid*
[31] The page numbering in the Cultural Resources section duplicated the numbering for the Biological Resources Section, thus all citations herein are listed as the proper number (C.3), as opposed to the incorrect number (C.2).

cultural properties, which are eligible for protection under the National Historic Preservation Act ("NHPA") [32]

BLM has failed to satisfy its obligations under section 106 of the NHPA. 16 U.S.C. § 470(f). This section of the NHPA requires agencies to take into account the impact of effects of their actions on historical resources "prior to the issuance of any license." 16 U.S.C. § 470(f). Instead of completing this required process, BLM is opting to use a programmatic agreement to defer evaluation, mitigation, and treatment until after approval.

Here again the assessment of impacts and the formulation of mitigation measures is impermissibly deferred. CEC plans to fulfill the bulk of its obligations under CEQA by conditioning approval on the applicant's compliance with a programmatic agreement whose contents are not disclosed. SA/DEIS C.3-50. The SA/DEIS admits that "staff is presently unable to identify precisely which of the different cultural resources are historically significant and is therefore presently unable to articulate the exact character of the effects that the construction of the proposed facility would have on such resources" and yet contends that "staff does foresee that the construction of the proposed facility would, under both NEPA and CEQA, have a significant effect on the environment and would, under Section 106, have an adverse effect on historic properties." SA/DEIS C.3-113. Further, even though the anticipated mitigation would rely on programs and protocols, the SA/DEIS acknowledges that "the specific programs and protocols do not presently exist." SA/DEIS C.3-113. This abdication of responsibility is clearly a violation of statutes enacted to ensure public participation in informed decision making and to protect our nation's irreplaceable cultural heritage.

Although the standard intensity of the geographic coverage in a project area of analysis would be 100%, here the geographic coverage only includes a sample of 25% of the archaeological sites. SA/DEIS C.2-49. Yet this inadequate sample size yielded no less than 401 archeological resources, including 248 isolates and 139 archeological sites. SA/DEIS C.3-79. Moreover, the applicant's studies have been questioned by Native Americans,[33] giving little confidence in the 25% sample that was used. Moreover, it was intended that the remaining 75% of the sites within the APE would also be subject to re-recordation, but "due to time constraints" the remaining 75% re-recordation effort of sites in the APE will be addressed as part of the terms and conditions of the Programmatic Agreement. SA/DEIS C.2-87. Before committing to the permanent destruction of irreplaceable cultural resources for the sake of a temporary project, CEC and BLM must, at the very least, determine the nature and extent of the cultural heritage they are obliterating.

[32] Tribal member comments, April 2010 BLM Programmatic Agreement workshop.
[33] *Id.*

VI. The SA/DEIS Fails to Analyze the Project's Short Term Gains Versus its Long Term Commitment of Irretrievable Resources

Clearly, this project falls into the category of those projects that cause a long-term loss of valuable resources in return for what could be a speculative short-term gain. In nearly every important public land resource category, such as biology, cultural, land use, soils and water the project has severe impacts, some of which are acknowledged by the SA/DEIS and some of which the SA/DEIS has failed to identify (as established elsewhere in these comments) or could not identify because it did not conduct necessary surveys.

Additionally, in weighing and balancing public land resource protection versus other goals, the SA/DEIS has failed to consider a major shortcoming of the project: its technology. The fact is that the use of Stirling engines for large scale solar power production is unproven at any scale approaching what is proposed here. The project technology has only been tested with 60 engines at 1.5 MW.[34]

Unproven technology was a major issue identified in scoping[35]. However, the SA/DEIS analysis give the issue short shrift.[36] However, the SA/DEIS acknowledges: "Staff cannot determine whether the predicted power plant availability factor of 99%, as supplied by the Applicant, is achievable. Further, staff cannot predict what the actual availability might be, *given the demonstration status of the SunCatcher technology* and limited data on large-scaled deployments of SunCatchers[37]" and "Staff believes it possible that the project may face challenges from considerable maintenance demands, reducing its availability." SA/DEIS ES-27 (emphasis added) In addition, over time this technology, with high maintenance requirements, may not be cost effective for power purchasers compared with other large scale solar thermal and PV models. This could result in an abandoned project, leaving a permanently degraded desert ecosystem, without the benefit of the planned solar energy plant's contribution to reducing global warming.

In view of the overwhelming number of unmitigated, and in many cases unmitigable, impacts of the "demonstration" project, plus the availability of environmentally preferable alternatives, how can the responsible agencies possibly justify approving the commitment of public

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34 See www.stirlingenergy.com/pdf/2009_8_19.

35 SA/DEIS B.2-13 ff.

36 the analysis recognizes the experimental nature of the technology but simply concludes that because there are 34,000 separate engines, the power plant staff should be able to keep a certain number operational SA/DEIS D.4-3.

37 Actually, there has been **no** large scale deployment of Suncatchers; the largest installation has been 60 units, or 1.5 MW. Please see http://www.stirlingenergy.com/pdf/2010_01_22.pdf

land resources for the development of a technology that is unproven at the scale proposed? This constitutes an experiment on a grand scale that will preclude sustainable multiple use on 13 square miles of high resource value public lands, and have undetermined impact on sensitive species and their long term survival and adaptation to changing climate. Accordingly, under CEQA, NEPA and FLPMA mandates, the project should be denied and should be sited in an alternative disturbed or degraded land location.

VII. The SA/DEIS Analysis of Soil and Water Issues is Inadequate Under CEQA and NEPA

a. The SA/DEIS fails to identify Significant Unmitigated Impacts of the Project

The project is located on an alluvial fan. SA/DEIS C.7-1, 35, 37. The onsite debris and retention basins propose to capture only 100 year storm flows. SA/DEIS C.7-28, 35, 36. However, it is well known that alluvial fans present unique and severe flood hazards.[38] Even the SA/DEIS acknowledges "the proposed project does constitute an unusual circumstance. Compared to other projects previously constructed on active alluvial fans, the proposed project is of a very large scale." SA/DEIS C.7-35. Thus, because of the location and enormous scale of the project actual impacts are unknown. This uncertainty is unacceptable under NEPA because it fails to provide the reviewer with an accurate project description or assessment of potential impacts.

Recently, the California Department of Water Resources established, and Federal Emergency Management Agency funded, an Alluvial Fan Task Force comprised of experts in hydrology, government agencies and other key stakeholders to examine the hazards of alluvial fan development and make recommendations.[39] One of the foremost recommendations of the Task Force was to plan for more than the normal 100 year flood.[40] *Alluvial Fan Task*

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[38] "Alluvial fan flooding differs from riverine flooding because flood flows in alluvial fan systems are often highly variable in magnitude. Compared to riverine flooding, there is considerably greater uncertainty in predicting the flow path of alluvial fan flooding with highly erosive soils mixed with water, rocks, boulders, trees and structural debris. Flood hazards on alluvial fans cannot be managed by riverine flood standards because the characteristics of alluvial fan flooding differ from the traditional riverine flooding paradigm." Alluvial Fan Task Force *Draft Findings and Recommendations* April 2010, 16.

[39] wri.csusb.edu/DWR_AlluvialFanTaskForce.html.

[40] The problems associated with assigning magnitude and frequency values to alluvial fan floods is even greater than riverine flooding because of the random nature of these events. Id. 23 "Recommendation 3 - Improved Flood Hazard Protection Standards: Local flood management agencies should consider higher levels of flood management protection above the 100-year FEMA regulatory standard in planning for development in alluvial fan areas." Id. 13.

Force Findings and Recommendations (attached hereto). That recommendation was not followed here. But even if the responsible agencies decide to only require protection from the standard project flood (100 year event), they must then acknowledge the potential for catastrophic consequences of the Project.[41]

The SA/DEIS identifies some potential for erosion, the vulnerability of the SunCatchers to damage and migration offsite,[42] and the inadequacy of information[43] and inadequate confidence level[44] in proposed flood control structures. But the SA/DEIS relies on the development of future information and design of standard project flood protection to fully mitigate the project's flood hazard potential. SA/DEIS C.7-65-68. The SA/DEIS fails to identify, analyze and mitigate the hazards unique to alluvial fans, such as shorter duration localized storms, massive debris flows, increased flows after fire events, and so forth,[45] instead of properly addressing this serious hazard.

In addition to special flood hazards, alluvial fans also provide unique and valuable resource benefits, such as water infiltration, wildlife connectivity, etc.[46] that were inadequately addressed in the SA/DEIS. The deficiencies of the wildlife connectivity analysis are outlined elsewhere in these comments. The question of project impacts to percolation and groundwater received scant mention and virtually no analysis. The SA/DEIS mentions that the project debris basins may evaporate water that otherwise percolated, but there is no adequate quantification or analysis of that potentially significant impact to groundwater supplies, given the project footprint of nearly 13 square miles. SA/DEIS B.1-10.

In view of its serious shortcomings, the SA/DEIS Soils and Water analysis with regard to alluvial fans and the potential for flooding and loss of valuable resources must be substantially revised in a re-circulated SA/DEIS in order to comply with the law.

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[41] CEQ says that reasonably foreseeable impacts include those that have catastrophic consequences, even if their probability of occurrence is low (1502.22, modified in 1986).
[42] C.7-1.
[43] SA/DEIS C.7-67, 2 and elsewhere.
[44] describes the proposed debris basins, stating "The design **attempts** to protect the project site from flooding, sediment deposition, and scour." SA/DEIS C.7-31 (emphasis added).
[45] Alluvial Fan Task Force *Draft Findings and Recommendations* April 2010, 29.
[46] Alluvial Fan Task Force *Draft Integrated Approach for Sustainable Development on Alluvial Fans 2010* p 50ff.

b. The SA/DEIS Fails to Provide the Required Information Related to Groundwater Use at the Site

The DEIS originally analyzed the environmental impact associated with the use of groundwater from the Cadiz Valley aquifers. The DEIS analyzes the impact of obtaining the groundwater from a Cadiz well and then transporting it 60 miles on rail cars to the project site. DEIS C.7-19. Staff concluded the impact would not be significant as recharge is expected to outpace pumping, and because the applicant would be required to comply with mitigation measures to assure that no significant environmental impact would occur. DEIS C.7-32. These conclusions are suspect as very little current information was provided on the capacity of the Cadiz well to serve the Project without affecting seeps and springs important to wildlife and the Mojave National Preserve. This is especially problematic in view of the cumulatively foreseeable (but inadequately analyzed) renaissance of the Cadiz Groundwater Storage and Dry-year Supply Program, a plan by Cadiz Land Company to sell massive amounts of groundwater out of the basin[47]. SA/DEIS C.7-14. Even more troubling is the new proposal by the Applicant to use an on-site well for the Project's water needs.

The applicant recently submitted a supplement to the Application for Certification changing its source of groundwater to a new well drilled adjacent to the project site. Supplemental Application for Certification 1-3. The environmental impact associated with this well and the use of its groundwater was not included in the DEIS, nor has it been made available to the public. The environmental impacts associated with the main source of the project's water—not only for the construction, but for the indefinite future use of the project—have the potential to be severe. The pumping could drain the source, thus disrupting the delicate and thirsty environment. In fact, the SA/DEIS acknowledges that originally the intent was to use the local basin, but "concern over sufficiency of this water supply" lead to the requirement to use the Cadiz Valley well. SA/DEIS B.1-12. All of this must be analyzed by the BLM in order to allow them to make an informed decision on the approval of this project. If it is not in the DEIS and is not considered then the purpose of NEPA to inform the decisionmakers and the public of the environmental impact of the project will be undercut. 40 C.F.R. § 1502.1.

c. The SA/DEIS Lacks Water Use & Discharge Plans

The SA/DEIS does not engage in a complete analysis of potential impacts associated with the Calico Project water use and discharge because

[47] "The Cadiz Water Conservation and Storage Project is designed to provide Southern California with as much as 150,000 acre-feet of groundwater during droughts, emergencies or other periods of need…" SA/DEIS C.7-59.

critical relevant information has yet to be obtained. In addition, although the SA/DEIS acknowledged the lack of information, it did not any legal reason for its omission. Instead, the SA/DEIS goes on to make conclusions about impacts and alternatives based on this inadequate information, all in violation of NEPA. 40 C.F.R. § 1502.22(a).

Possible consequences associated with the construction and operation of the project, which would be located on several undeveloped alluvial fans, include increased soil erosion, substantial depletion or degradation of groundwater resources, dispersal of contaminants to soil or groundwater and an increase in downstream flooding. SA/DEIS C-7.27, .31, .34, .35. The SA/DEIS is inadequate because conclusions regarding the significance of the environmental impacts of the Proposed Project and its alternatives discussed above are drawn without vital information.

According to the SA/DEIS, the applicant has yet to provide "information necessary to complete development of requirements for dredge and fill in waters of the state." SA/DEIS C.7-2. This information is vital for the public's understanding of the impacts of the proposed project, because waste discharge has the potential to seriously affect the delicate desert environment. Staff asserts that they are unable to "complete development of requirements that will be included in Condition of Certification Soil&Water-2," also known as the Waste Discharge Requirements, until this information is provided. *Id.* Under NEPA, BLM is required to take a hard look at the environmental consequences of a proposed action, which requires agencies to consider the relevant factors and the important aspects of their actions. *See Friends of the Boundary Waters Wilderness v. Dombeck*, 164 F.3d 1115, 1128 (8th Cir. 1999). Conclusory statements are not a substitute for analysis under NEPA. *Envtl. Defense Fund v. Froehlke*, 473 F.2d 346, 348 (8th Cir. 1972) (an EIS cannot be composed of statements "too vague, too general and too conclusionary").

Further, the applicant has also failed to provide "information necessary to complete development of requirements for discharges of brine waters to evaporation ponds or sanitary septic systems." SA/DEIS C.7-2. This information is also necessary for completion of the Waste Discharge Requirements. *Id.* Not only is the discharge information vital, but the information concerning evaporation ponds is also key because of the harmful impact the toxins released from the evaporation ponds may have on wildlife. SA/DEIS C.2-40.

Four of the main conclusions of the SA/DEIS are based on adherence to requirements not yet created because of a lack of information. The SA/DEIS clearly states that development of these Waste Discharge Requirements is vital to the conclusions reached regarding environmental effects because compliance with these requirements will ensure: "no adverse alteration of drainage patterns"; "no violation of water quality standards or waste discharge requirements"; "that the project not create or contribute runoff water that exceeds existing or planned storm water-drainage system capacity or provides substantial additional sources of polluted runoff;" "no degradation of surface water or groundwater quality." *Id.* C.7-42-44. The SA/DEIS concludes that all of these adverse impacts will be avoided, at least partially because of these requirements. *Id.* Without this information, it is impossible for the BLM to make a reasoned decision with regard to the Calico Project because of the enormous uncertainty associated with the hydrological environmental impact. These undeveloped Waste Discharge Requirements are essential to the BLM's reasoned decision. The conclusions reached in theSA/DEIS lack the proper analysis required by NEPA, thus making the SA/DEIS inadequate.

The water analyses for two of the alternative projects are also inadequate due to lack of information. The same information missing for the Proposed Project water analysis is also missing for the Reduced Acreage Alternative and the Avoidance of Donated and Acquired Lands Alternative. *See id.* C.7-44-46. This missing information would be enough to make the analyses of these alternatives inadequate, but the analyses go one step further and fail to even mention Waste Discharge Requirements for either of these two alternatives. *See id.*

In order to allow a reasoned decision to be made regarding the Proposed Project or its alternatives, all the necessary information needs to be available to the BLM. For the Reduced Acreage Alternative, the SA/DEIS states: "Potential impacts identified for both the construction and operation phases of the project include impacts on soil erosion, sedimentation, flooding, water quality, and water supply. All of the potential impacts identified for the proposed project remain with the Reduced Acreage Alternative. However, due to the alternative's reduced physical size and reduction in number of SunCatchers, these potential impacts are proportionately reduced." *Id.* C.7-44. There is no further discussion of mitigation strategies or Waste Discharge Requirements, or which requirements will be lessened due to the decrease in size. The analysis is overly condensed and vague, making the water analysis for this alternative unacceptable.

Similarly, the Avoidance of Donated and Acquired Lands Alternative is devoid of a serious water analysis. The SA/DEIS states: "Provided the redesign of the flood control and erosion/sedimentation control structures meet the same standards as for the Calico Solar Project, no change to the CEQA Level of Significance of impacts would occur between the proposed project and the Avoidance of Donated and Acquired Lands Alternative." *Id.* C.7-46. Again, the BLM must require more information regarding the comparison between the Proposed Project and the alternatives in order to make a reasoned decision. There is no discussion as to how the mitigation strategies will be different or how the impact will be different or the same. As stated above, conclusory statements are not an acceptable substitute for analysis. *See Froehlke*, 473 F.2d at 348. Because of this deficiency, the analysis for this alternative is inadequate.

VIII. BLM Does Not Adequately Analyze the Project Under the Requirements of FLPMA and the CDCA

The Federal Land Policy and Management Act (FLPMA) was enacted in 1976 in part to ensure that public lands are:

> managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will pro-vide for outdoor recreation and human occupancy and use.

43 U.S.C. 1701. Recognizing that the California desert is a rare and special place, Congress designated a large portion of the Southern California desert as the California Desert Conservation Area (CDCA). 43 U.S.C. § 1781(c). Congress understood that "the California desert environment is a total ecosystem that is extremely fragile, easily scarred, and slowly healed." 43 U.S.C. § 1781(a)2. Accordingly, FLPMA requires the preparation and implementation of the CDCA Plan, "a comprehensive, long-range plan for the management, use, development and protection of these lands " 43 U.S.C. § 1781(d). The purpose outlined in the CDCA Plan is to provide for "multiple use and sustained yield, and the **maintenance of environmental quality**." 43 U.S.C. 1781(b).

FLPMA mandates the BLM to "take any action necessary to prevent unnecessary or undue degradation of the lands." 43 U.S.C § 1732(b). To ensure the overall maintenance of environmental quality, the CDCA Plan must provide a desert-wide perspective of the planning decisions for each major resource or issue of public concern. Since the CDCA Plan was completed in 1980, there have been only two major amendments affecting the Mojave desert, the Northern and Eastern Mojave Management (NEMO) Plan in 2002 and the Western Mojave Management (WEMO) Plan in 2006. But neither of these amendments nor the CDCA Plan contemplated cumulative industrial development which could be as high as 500,000 to 1,000,000 acres as reflected in renewable energy development applications on public land in the California desert. Thus, there is no desert-wide planning perspective for land conversion of this scale and intensity. The Calico Project alone entails thirteen square miles of industrialization, with attendant loss of all biological resources onsite, all habitat connectivity through the project and immediate environs, loss of all public access, all visual resources, all recreational value, etc. Here also, the proposed CDCA Plan Amendment does not take into account a desert-wide perspective; rather it simply proposes that "[p]ermission [is] granted to construct solar energy facility (proposed Calico Solar Project)." SA/DEIS A.6. Moreover, this action is proposed without any appropriate planning level guidance.

The Project is located in public lands that are designated as Class L. According to the CDCA Plan, "[m]ultiple-Use Class L (Limited Use) protects sensitive, natural, scenic, ecological, and cultural resource values. Public lands designated as Class L are managed to provide for generally lower-intensity, carefully controlled multiple use of resources, while ensuring that sensitive values are not significantly diminished." CDCA Plan 13. As such, the Plan should not be amended to allow for large scale industrial development unless "sensitive values are not diminished." Here, however, the Project will cause a long-term loss of valuable resources, sensitive plants, and protected species. In nearly every important public land resource category – biological, cultural, land use, recreation, visual, wilderness ,soils, water, etc. – the project has severe impacts, some of which are acknowledged by the SA/DEIS and some of which the SA/DEIS has failed to identify.

Under FLPMA BLM must "[p]repare and maintain on a continuing basis an inventory of all public lands and their resource and other values." The inventory must be kept current "so as to reflect changes in conditions and to identify new and emerging resource and other values." 43 U.S.C. § 1711(a). FLPMA requires that this inventory form the basis of the land use planning process. 43 U.S.C. § 1701(a)(2). In *ONDA v. Rasmussen,* (D.Or. 2006) 451 F.Supp. 2d 1202, 1212-13, the court held that BLM failed to satisfy the "hard look" requirement of NEPA because they relied on outdated inventories, in violation of FLPMA. *See also Center for Biological Diversity v. Bureau of Land Management*, 422 F.Supp.2d 1115, 1166-67 (N.D. Cal. 2006). Here too, BLM is violating its mandate by proposing a one-sentence Plan Amendment without adequately identifying the species and resources that will be affected by the Amendment.

As discussed above, BLM has failed to adequately characterize the public lands and resources that will be affected by the Project. These include, but are not limited to, the desert tortoise, Mojave fringe-toed lizard, Nelson's bighorn sheep, golden eagle, and multiple resources impacted by potential groundwater issues and flooding concerns. Multiple areas of the SA/DEIS state that surveys are still ongoing or are concurrent with the public comment period; not only is the deferral of surveys contrary to NEPA, but it also violates the BLM's responsibilities under FLPMA and the CDCA. Under FLPMA BLM must "take any action necessary to prevent unnecessary or undue degradation of the lands" and "minimize adverse impacts on the natural, environmental, scientific, cultural, and other resources and values (including fish and wildlife habitat) of the public lands involved." 43 U.S.C. §§ 1732(b), 1732(d)(2)(a). Here, however, the SA/DEIS does not adequately address the consequences associated with translocating up to 340 threatened desert tortoises, and provides almost no information related to the effect this project will have on the habitat requirements of the Nelson's bighorn sheep. SA/DEIS C.2-89. These vital data gaps illustrate that BLM cannot adequately show that they are preventing unnecessary degradation of public lands.

Further, FLPMA requires that when the BLM is amending a land use plan, they must "use a systematic interdisciplinary approach to achieve integrated consideration of physical, biological, economic, and other sciences . . . consider the relative scarcity of the values involved . . ." 43 U.S.C. § 1712(c). Here, the SA/DEIS has not assembled enough information and analysis and the responsible agencies do not have adequate guidance to determine: 1) the level of cumulative impacts to habitats, species and ecosystems, especially in the context of likely climate-change-necessitated habitat and species migration; 2) the limits of acceptable change, or; 3) how to avoid significant cumulative impacts that would foreclose future opportunities to sustain desert ecosystems and species.

Additionally, BLM does not look into any alternative plan amendments, and appears to have looked at this amendment in isolation. However, under CDCA requirements, the BLM must determine "if alternative locations within the CDCA are available which would meet the applicant's needs without requiring a change in the Plan's classification . . . " and evaluate "the effect of the proposed amendment on BLM management's desert-wide obligation to achieve and maintain a balance between resource use and resource protection." CDCA Plan 121. As discussed below, the SA/DEIS does not adequately examine alternatives to the Project, and neglects to perform a thorough cumulative impact analysis. As the CDCA was designed to provide broad, **regional** guidance (CDCA Plan 11), the BLM should examine this project not only as to the effects on the Western Mojave, but also on the Mojave ecosystem and the CDCA as a whole. Without this analysis the overarching planning principles inherent in FLPMA and CDCA will be undermined. As such, this CDCA Plan Amendment should not be approved until the missing information is provided and the BLM provides a region-wide assessment per CDCA and FLPMA.

IX. If an Action is Taken, BLM Should Adopt the Private Land Alternative or the No Action "Unavailable" Alternative

Sierra Club, recognizing the known very significant impacts this project poses to desert tortoise and the unknown but very likely impacts to a long list of other resources as enumerated above, supports a Private Land Alternative to the proposed project. We believe the option of siting such a project on Cadiz Land Company previously disturbed land is feasible and should be analyzed by BLM along with the SA/DEIS identified Private Land Alternative. But the SA/DEIS also studies three No Action Alternatives under NEPA, each of which would result in a different CDCA Plan: (1) the No Action/No CDCA Plan Amendment Alternative; (2) the No Action/Amend the CDCA to make the area available for future solar development Alternative; and (3) the No Action/Amend the CDCA to make the area unavailable for future solar development Alternative ("Unavailable Alternative"). Of these three, we support the third alternative because it will provide the greatest protection to this immaculate landscape, will ensure that the character of the area is preserved for future generations, and will preserve options needed to ensure species and ecosystem sustainability into the future.

The SA/DEIS recognizes that adoption of this alternative would prevent future environmental impacts from other renewable energy projects. Unless this alternative is adopted, "other renewable energy projects" with "similarly" devastating environmental and cultural impacts could be approved. SA/DEIS C.3-126. Adoption of the Unavailable Alternative would also prevent future impacts to the desert tortoise, Nelson's bighorn sheep, and special-status plant species. SA/DEIS B.2-18. BLM should demonstrate its commitment to the preservation of our nation's rapidly disappearing desert lands by adopting the Unavailable Alternative or a Private Land Alterative site. If action other than these alternatives are taken, a supplemental SA/DEIS must be issued to correct major deficiencies under NEPA and CEQA.

Conclusion

As discussed above, critical information was omitted from the SA/DEIS. Given the importance and sheer volume of omitted information, the public has been deprived of the opportunity to comment on the project in a meaningful way. Under these circumstances, both NEPA and CEQA require new wildlife surveys and development of other critical information as well as recirculation of the amended environmental document. Because NEPA and CEQA are intended to provide the public with access to high-quality information, it is unlawful to release the DEIS and then attempt to fix its problems out of the public eye.

Therefore, the Sierra Club respectfully requests that the BLM revise and recirculate the DEIS consistent with these comments or reject the ROW application. Thank you for your consideration.

Dated: July 1, 2010

Respectfully submitted,

Joan Taylor

____

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APPLICATION FOR CERTIFICATION
For the CALICO SOLAR (Formerly SES Solar One)

Docket No. 08-AFC-13

PROOF OF SERVICE

(Revised 6/14/10)

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*indicates change

DECLARATION OF SERVICE

I, Katie Schaefer, declare that on July 1, 2010, I served and filed copies of the attached Sierra Club Comments on the Calico Solar Project, . The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at: **[www.energy.ca.gov/sitingcases/solarone]**.

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

(Check all that Apply)

FOR SERVICE TO ALL OTHER PARTIES:

X sent electronically to all email addresses on the Proof of Service list;

___ by personal delivery;

X by delivering on this date, for mailing with the United States Postal Service with first-class postage thereon fully prepaid, to the name and address of the person served, for mailing that same day in the ordinary course of business; that the envelope was sealed and placed for collection and mailing on that date to those addresses **NOT** marked "email preferred."

AND

FOR FILING WITH THE ENERGY COMMISSION:

X sending an original paper copy and one electronic copy, mailed and emailed respectively, to the address below (***preferred method***);

OR

___ depositing in the mail an original and 12 paper copies, as follows:

CALIFORNIA ENERGY COMMISSION
Attn: Docket No. 08-AFC-13
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
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I declare under penalty of perjury that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

*indicates change

2009 California Climate Adaptation Strategy

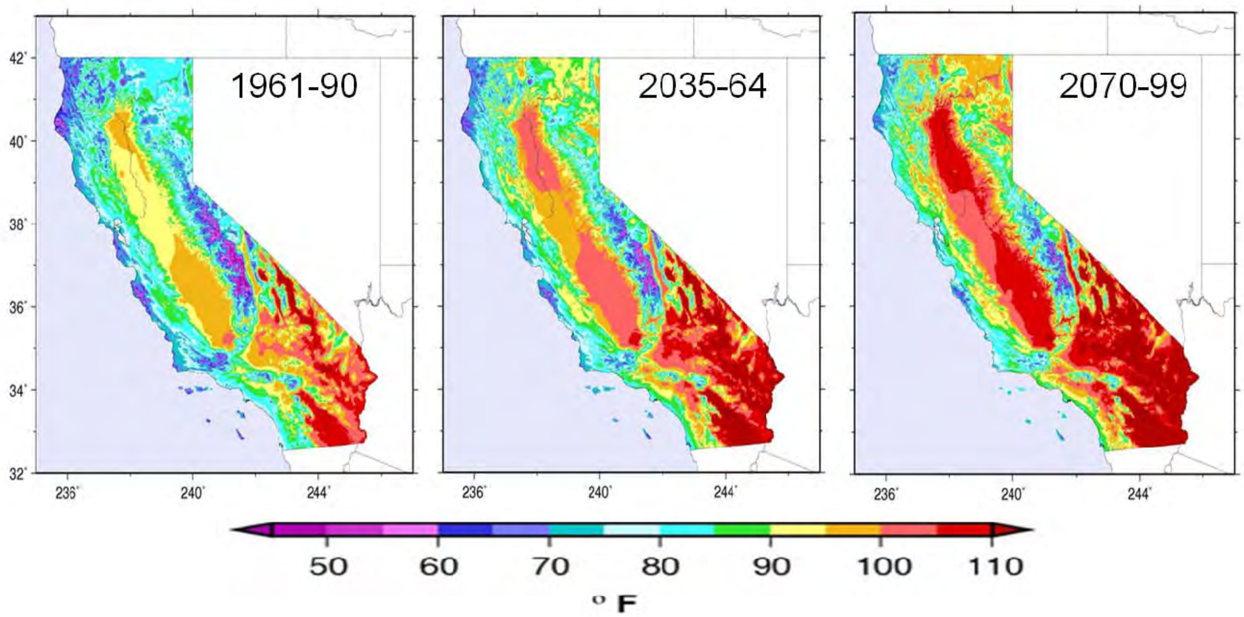
Discussion Draft

A Report to the Governor of the State of California
in Response to Executive Order S-13-2008

Public Review Draft

California natural resources Agency

Figure 1. California Historical & Projected July Temperature Increase 1961-2099



Source: Dan Cayan et al. 2009.

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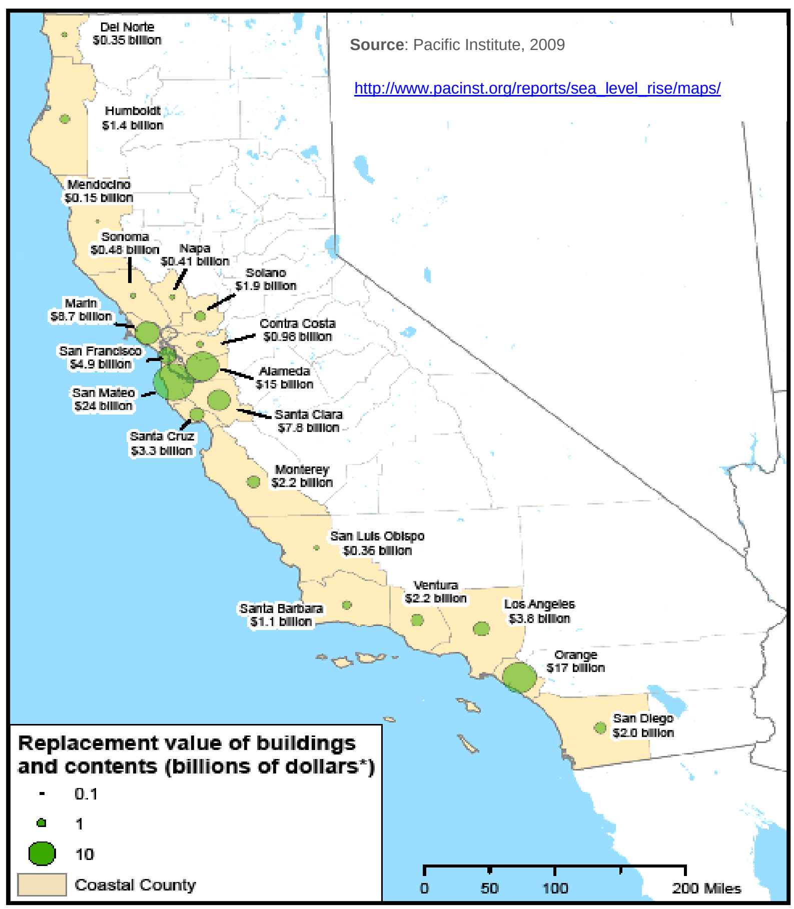
The Golden State at Risk

Climate change is already affecting California. Sea levels have risen by as much as seven inches along the California Coast over the last century, increasing erosion and pressure on the state's infrastructure, water supplies, and natural resources. The state has also seen increased average temperatures, more extreme hot days, fewer cold nights, a lengthening of the growing season, shifts in the water cycle with less winter precipitation falling as snow, and both snowmelt and rainwater running off sooner in the year.

These climate driven changes affect resources critical to the health and prosperity of California. For example, forest wildland fires are becoming more frequent and intense due to dry seasons that start earlier and end later. The state's water supply, already stressed under current demands and expected population growth, will shrink under even the most conservative climate change scenario. Almost half a million Californians, many without the means to adjust to expected impacts, will be at risk from sea level rise along bay and coastal areas. California's infrastructure is already stressed and will face additional burdens from climate risks. And as the Central Valley becomes more urbanized, more people will be at risk from intense heat waves.

If the state were to take no action to reduce or minimize expected impacts from future climate change, the costs could be severe. A 2008 report by the University of California, Berkeley and the non-profit organization Next 10 estimates that if no action is taken in California, damages across sectors would result in "tens of billions of dollars per year in direct costs" and "expose ***trillions*** of dollars of assets to collateral risk." More specifically, the report suggests that of the state's $4 trillion in real estate assets "$2.5 trillion is at risk from extreme weather events, sea level rise, and wildfires" with a projected annual price tag of up to $3.9 billion over this century depending on climate scenarios (www.next10.org/research/research_ccrr.html). The figure at right, from a study by the Pacific Institute, shows coastal property at risk from projected sea level rise by county with replacement values as high as $24 billion in San Mateo County.

Figure 2: *Replacement value of buildings and contents vulnerable to a 100 year coastal flood with 1.4 meters of sea level rise*



Source: Heberger et al. 2009.

California understands the importance of addressing climate impacts today. The state strengthened its commitment to managing the impacts from sea level rise, increased temperatures, shifting precipitation and extreme weather events when Governor Arnold Schwarzenegger signed Executive Order (EO) S-13-08 on November 14, 2008. The order called on state agencies to develop California's first strategy to identify and prepare for these expected climate impacts.

The *2009 California Climate Adaptation Strategy Discussion Draft* report summarizes the best known science on climate change impacts in the state to assess vulnerability and outline possible solutions that can be implemented within and across state agencies to promote resiliency. This is the first step in an ongoing, evolving process to reduce California's vulnerability to climate impacts.

The California Natural Resources Agency (CNRA) has taken the lead in developing this draft adaptation strategy, working through the Climate Action Team (CAT). Seven sector-specific working groups led by 12 state agencies, boards and commissions, and numerous stakeholders were convened for this effort. The strategy proposes a comprehensive set of recommendations designed to inform and guide California decision makers as they begin to develop policies that will protect the state, its residents and its resources from a range of climate change impacts. The CNRA will revise this draft adaptation strategy based on public input gathered over the next 45 days.

California's Climate Adaptation Strategy

As the climate changes, so must California. To effectively address the challenges that a changing climate will bring, climate adaptation and mitigation (i.e., reducing state greenhouse gas (GHG) emissions) policies must complement each other, and efforts within and across sectors must be coordinated. For years, the two approaches have been viewed as alternatives, rather than as complementary and equally necessary approaches.

Adaptation is a relatively new concept in California policy. The term generally refers to efforts to respond to the ***impacts*** of climate change – adjustments in natural or human systems to actual or expected climate changes to minimize harm or take advantage of beneficial opportunities.

California's ability to manage its climate risks through adaptation depends on a number of critical factors including its baseline and projected economic resources, technologies, infrastructure, institutional support and effective governance, public awareness, access to the best available scientific information, sustainably-managed natural resources, and equity in access to these resources.

As the *2009 California Climate Adaptation Strategy Discussion Draft* illustrates, the state has the ability to strengthen its capacity in all of these areas. In December 2008, the California Air Resources Board released the state's *Climate Change Scoping Plan*, which outlines a range of strategies necessary for the state to reduce its GHG emissions to 1990 levels by 2020. Many climate mitigation strategies, like promoting water and energy efficiency, are also climate adaptation strategies. By building an adaptation strategy on existing climate science and frameworks like the Scoping Plan, California has begun to effectively anticipate future challenges and change our actions that will ultimately reduce the vulnerability of residents, resources and industries to the consequences of a variable and changing climate.

To ensure a coordinated effort in adapting to the unavoidable impacts of climate change, the *2009 California Climate Adaptation Strategy Discussion Draft* was developed using a set of guiding principles:

- Use the best available science in identifying climate change risks and adaptation strategies.
- Understand that data continues to be collected and our knowledge about climate change is still evolving. As such, an effective adaptation strategy is "living" and will itself be adapted to account for new science.
- Involve all relevant stakeholders in identifying, reviewing, and refining the state's adaptation strategy.
- Establish and retain strong partnerships with federal, state, and local governments, tribes, private business and landowners, and non-governmental organizations to develop and implement adaptation strategy recommendations over time.
- Give priority to adaptation strategies that initiate, foster, and enhance existing efforts that improve economic and social well-being, public safety and security, public health, environmental justice, species and habitat protection, and ecological function.
- When possible, give priority to adaptation strategies that modify and enhance existing policies rather than solutions that require new funding and new staffing.
- Understand the need for adaptation policies that are effective and flexible enough for circumstances that may not yet be fully predictable.
- Ensure that climate change adaptation strategies are coordinated with the California Air Resources Board's AB 32 Scoping Plan process when appropriate, as well as with other local, state, national and international efforts to reduce GHG emissions.

The *2009 California Climate Adaptation Strategy Discussion Draft* takes into account the long-term, complex, and uncertain nature of climate change and establishes a proactive foundation for an ongoing adaptation process. Rather than address the detailed impacts, vulnerabilities, and adaptation needs of every sector, those determined to be at greatest risk are prioritized.

The development of the adaptation strategies presented within this report was spearheaded by the state's resource management agencies. CNRA staff worked with seven sector-based Climate Adaptation Working Groups (CAWGs) focused on the following areas: public health; ocean and coastal resources; water supply and flood protection; agriculture; forestry; biodiversity and habitat; and transportation and energy infrastructure.

Working group experts have an intimate knowledge of California's resources, environments, and communities, and also of the state's existing policy framework and management capabilities. This understanding informs the draft adaptation strategy and ensures a realistic assessment of adaptive capacities, current limitations, and future needs.

A Collaborative Approach

This draft adaptation strategy could not have been developed without the involvement of numerous stakeholders. Converging missions, common interests, inherent needs for cooperation, and the fact that climate change impacts cut across jurisdictional boundaries will require governments, businesses, non-governmental organizations, and individuals to minimize risks and take advantage of potential planning opportunities.

Throughout the development of this report, it became increasingly clear that overlapping missions and goals will require agencies and organizations at all levels to work together to develop close partnerships with regard to climate adaptation. This is the only means by which the far reaching effects of climate impacts can be addressed efficiently and effectively while avoiding potential conflicts. The Comprehensive State Adaptation Strategies chapter underscores the need for collaboration and identifies where cross-sector relationships are necessary.

To further enhance stakeholder participation, seven Climate Adaptation Working Groups (CAWGs) initiated a process that allowed for consultation with stakeholders through public workshops and review opportunities. This input has considerably shaped the content and refinement of this draft report. However, future updates of the draft adaptation strategy will require ongoing input through active stakeholder engagement and an even closer integration of state agency efforts. Public comment gathered during the next 45 days will be incorporated into recommendations and a final version of the report (see www.climatechange.ca.gov/adaptation).

In order to best analyze climate change risks, the *2009 California Climate Adaptation Strategy Discussion Draft* draws on years of state-specific science and impacts research, largely funded through the California Energy Commission's Public Interest Energy Research (PIER) Program and an engaged research community. The research provides for an understanding of the climate-related risks California will face and has significantly contributed to greater public awareness of climate change. As data continues to be developed and collected, the state's adaptation strategy will be updated to reflect current findings.

Preliminary Recommendations

The preliminary recommendations outlined in this draft adaptation strategy were developed by CNRA staff, CAWGs, the CAT, and from public comments. The public comment period will collect input from stakeholders about how these draft recommendations should be modified, if necessary. It is recognized the implementation of the following strategies will require significant collaboration among multiple stakeholders to ensure they are carried out in a rational, yet progressive manner over the long term. These strategies distinguish between near-term actions that will be completed by the end of 2010 and long-term actions to be developed over time, and are covered in more detail in the sector chapters in Part II of this report.[i]

Key recommendations include:

1. A Climate Adaptation Advisory Panel (CAAP) will be appointed to assess the greatest risks to California from Climate Change and recommend strategies to reduce those risks building on California's Climate Adaptation Strategy. This Panel will be convened by the California Natural Resources Agency, in coordination with the Governor's Climate Action Team, to complete a report by

[i] Each of the twelve Executive Summary strategies is drawn from multiple strategies within the subsequent sector specific and cross-sector adaptation strategy chapters. The recommendations here may not reflect exact wording of individual sector recommendations but relate to their core message. Each Executive Summary recommendation here lists the sector and recommendation number using the following acronyms to identify the sector: Public Health (PH), Biodiversity and Habitat (BH), Ocean and Coastal Resources (OCR), Water Management (W), Agriculture (A), Forestry (F), Transportation and Energy Infrastructure (TEI), and Cross-Sector (CS).

December 2010. The CNRA will continue to act as the lead Climate Adaptation Office until subsequent guidance is provided by the CAAP.

2. California must change its water management and uses because climate change will likely create greater competition for limited water supplies needed by the environment, agriculture, and cities. As directed by the Governor, state agencies must implement strategies to achieve a statewide 20 percent reduction in per capita water use by 2020, expand surface and groundwater storage, implement the Delta Vision Cabinet Group recommendations to fix Delta water supply, quality, and ecosystem conditions, support agricultural water use efficiency, and improve state-wide water quality. Improve Delta ecosystem conditions and stabilize water supplies as developed in the Bay Delta Conservation Plan. (BH-2, W-3, 6, and 7; A-3; TEI-3).

3. Consider project alternatives that avoid significant new development in areas that cannot be adequately protected (planning, permitting, development, and building) from flooding due to climate change. The most risk-averse approach for minimizing the adverse effects of sea level rise and storm activities is to carefully consider new development within areas vulnerable to inundation. State agencies should generally not plan, develop, or build any new significant structure in a place where that structure will require significant protection from sea-level rise, storm surges, or coastal erosion during the expected life of the structure. However, vulnerable shoreline areas containing existing and proposed development that have regionally significant economic, cultural, or social value may have to be protected, and in-fill development in these areas should be accommodated. State agencies should incorporate this policy into their decisions, and other levels of government are also encouraged to do so. (CS-2; OCR-1 and 2; W-4; TEI -1).

4. All state agencies responsible for the management and regulation of public health, infrastructure or habitat subject to significant climate change should prepare as appropriate agency-specific adaptation plans, guidance, or criteria by September 2010. (PH-8; BH-1, 2, and 6; OCR-3; F-1 and 2; TEI-2 and 5).

5. All significant state projects, including infrastructure projects, must consider climate change impacts, as currently required under CEQA Guidelines Section 15126.2. (BH-2).

6. The California Emergency Management Agency (Cal EMA) will collaborate with CNRA and the seven sector-based Climate Adaptation Working Groups (CAWGs) to assess California's vulnerability to climate change, identify impacts to State assets, and promote climate adaptation/mitigation awareness through the Hazard Mitigation Web Portal and My Hazards website as well as other appropriate sites. The transportation sector CAWG, led by Caltrans, will specifically assess how transportation nodes are vulnerable and the type of information that will be necessary to assist response to district emergencies. Climate change impacts were recognized in the 2007 State Hazard Mitigation Plan (SHMP) as having an effect on primary hazards such as flooding and wildfires and secondary hazards such as levee failure and landslides. Special attention will be paid to the most vulnerable communities impacted by climate change. (CS-3 and 5; PH-4 and 5; OCR-5; W-4; F-2 and 3; TEI-5, 6 and 8).

7. The State should identify key California land and aquatic habitats from existing research that could change significantly this century due to climate change. Based on this identification the state should develop a plan for expanding existing protected areas or altering land and water management practices to minimize adverse effects from climate change induced phenomena. (BH-1; W-5; F-5).

8. The California Department of Public Health will develop guidance by September 2010 for use by local health departments and other agencies to assess mitigation and adaptation strategies, which include impacts on vulnerable populations and communities and assessment of cumulative health impacts. This includes assessments of land use, housing and transportation proposals that could impact health, GHG emissions, and community resilience for climate change, such as in the 2008 Senate Bill 375 regarding Sustainable Communities. The best long-term strategy to avoid increased health impacts from climate change is to ensure communities are healthy to build resilience to increased spread of disease and temperature increases. (PH-3).

9. Communities with General Plans and Local Coastal Plans should begin when possible to amend their Plans to assess climate change impacts, identify areas most vulnerable to these impacts, and to develop reasonable and rational risk reduction strategies using the Draft California Adaptation Strategy as guidance. Every effort will be made to provide tools to assist in these efforts. (BH-1; OCR– 2 and 4; CS-2).

10. State fire fighting agencies should begin immediately to include climate change impact information into fire program planning to inform future planning efforts. Enhanced wildfire risk from climate change will likely increase public health and safety risks, property damage, fire suppression and emergency response costs to government, watershed and water quality impacts, and vegetation conversions and habitat fragmentation. (PH-4 and 5; F-1; TEI-3).

11. State agencies should meet projected population growth and increased energy demand with greater energy conservation and increased use of renewable energy. Renewable energy supplies should be enhanced through the Desert Renewable Energy Conservation Plan that will protect sensitive habitat that will help reach the state goal of having 33 percent of the state's energy supply from renewable energy by 2020. (TEI-2).

12. Existing and planned climate change research can and should be used for state planning and public outreach purposes; new climate change impact research should be broadened and funded. By September 2010, a user friendly web-based map and interactive website will be developed and regularly updated by the California Energy Commission to synthesize existing California climate change scenario and climate impact research and to encourage its use in a way that is useful for local decision-makers. Every effort will be made to increase funding for climate change research. (CS-4 and 6; PH-7; BH-4; OCR-6; W-8, 9, and 10; A – 8; F-4 and 5; TEI-3 and 9).

PART I: PLANNING FOR CLIMATE CHANGE

I. INTRODUCTION

Recognizing the Need to Adapt

With the growing recognition that climate change is already underway and science that suggests additional impacts are inevitable despite mitigation efforts, adaptation planning is rapidly becoming an important policy focus in the United States and internationally.

In many states, efforts are beginning in nearly every sector of society, ranging from coastal planning for higher sea levels and reviews of water and drought management strategies, to climate-cognizant species preservation and habitat conservation planning, to adjustments in the financial sector.

Historically, California state agencies and private entities have adjusted their practices to account for climate impacts. For example, reservoirs and levees have been built to protect against common winter and springtime floods and periods of summer drought. In agriculture, improvements in irrigation efficiency have been made to better guarantee water reliability and supply. For public safety, local health departments have opened cooling centers during heat emergencies.

Figure 3: Governor Schwarzenegger assesses the site of a recent wildfire

To expand upon these efforts based on the most current science, Governor Schwarzenegger's Executive Order S-13-08 provides clear direction on developing California's first statewide climate adaptation effort. This report focuses on Article 7 of the order, which goes on to (1) request that the National Academy of Science (NAS) establish an expert panel to report on sea level rise impacts in California to inform state planning and development efforts (Articles 1-3); (2) review the NAS assessment every two years or as necessary (Article 4); (3) issue interim guidance to state agencies about how to plan for sea level rise in designated coastal and floodplain areas for new projects (Article 5); and (4) initiate a report on critical existing and planned infrastructure projects vulnerable to sea level rise (Articles 6 and 8).

Article 7 states:

> *"By June 30, 2009, the California Resources Agency, through the Climate Action Team, shall coordinate with local, regional, state and federal public and private entities to develop a state Climate Adaptation Strategy. The strategy will summarize the best known science on climate change impacts to California (led by the Energy Commission's PIER program), assess California's vulnerability to the identified impacts and then outline solutions that can be implemented within and across state agencies to promote resiliency. A water adaptation strategy will be coordinated by DWR with input from the State Water Resources Control Board, an ocean and coastal resources adaptation strategy will be coordinated by the OPC, an infrastructure*

adaptation strategy will be coordinated by the California Department of Transportation, a biodiversity adaptation strategy will be jointly coordinated by the California Department of Fish and Game and California State Parks, a working landscapes adaptation strategy will be jointly coordinated by the California Department of Forestry and Fire Protection and the California Department of Food and Agriculture, and a public health adaptation strategy will be jointly coordinated by the California Department of Public Health and the California Air Resources Board, all as part of the larger strategy. This strategy will be facilitated through the Climate Action Team and will be coordinated with California's climate change mitigation efforts."

Climate Modeling

For California to ensure coping capacity and long-term resiliency, researchers have previously developed two distinct approaches: (1) projecting the amount of climate change that may occur and (2) assessing the natural or human system's ability to cope with and adapt to change. In recent years, these approaches have been seen as complementary and as such, both are needed to understand climate risks, vulnerabilities, and interventions that can help society and ecosystems adapt successfully.

(1) Hazards-Based Approach

In the hazards-based approach, emissions scenarios are identified that allow scientists to evaluate the degree of climate change projected. Typically, these climate changes are projected for decades or centuries using increasingly sophisticated, computer-based global climate models. These projections are used to assess the physical, ecological, or economic consequences for specific sectors and environments.

In this approach, any changes identified outside of the historical norm would then require adaptation. For example, if the impact is estimated to be substantial, then substantial adaptation is required; if the impact is determined to be gradual, there is time to engage in adaptation planning. In a hazards-based approach, various non-climatic factors are not addressed; nor are specific adaptation plans identified.

(2) Vulnerability-Based Approach

Conversely, the vulnerability-based approach is focused on the socioeconomic and ecological factors that determine a system's vulnerability and ability to cope with and adapt to climate change. Typically, such an assessment also explicitly examines past experience with climate variability and extremes to see how systems have responded. The conditions that influence vulnerability for a given area can provide a baseline that, when combined with existing conditions, communities may use to determine what actions are needed to respond to climate impacts. It is also important to understand how existing conditions will react to the additional influence of climate change. A good example is how existing drought cycles could be exacerbated by changing weather patterns from climate change.

Both the hazards-based and the vulnerability-based approaches are ultimately needed for any long-term and iterative process of climate change adaptation. They will allow California to identify the most important climate risks, establish priorities, assess options and barriers, and evaluate the effectiveness of adaptive responses in a place-based context given the stresses and demands on resources. Adaptation planning requires an understanding of climate impacts and substantial input from the social, economic, engineering, and ecological sciences on those factors that affect vulnerability and adaptation.

Drawing on currently available science, this report includes the most recent climate projections and related impacts studies identified as part of a hazards-based approach. What are needed now are future vulnerability-based assessments.

Adaptation Strategy Vision, Objectives and Principles

The basic purpose and overarching goal of the *2009 California Climate Adaptation Strategy Discussion Draft* is to begin a statewide, ongoing, and committed process of adapting to a changing climate in the context of other changes in the environment, the economy, and society.

To achieve this goal, the draft adaptation strategy pursues the following specific objectives:

Analyze climate change risks. Synthesize to the greatest extent possible, how temperature rise, extreme weather events, precipitation changes, seasonal shifts, and sea level rise will exacerbate existing fire, flood, water supply and quality, air quality, habitat loss, and human health risks. Assess how these changes will impact the state's economy, infrastructure, human populations, and environment.

Identify sector-specific, and to the extent possible, cross-sectoral adaptation strategies that help reduce vulnerabilities and build climate resilience. Attention should be given to strategies that help (a) avoid, prevent, or minimize climate change impacts to public health, biodiversity, working landscapes, and infrastructure, (b) improve preparedness for climate change impacts and extreme events, (c) enhance the state's response capacity in case of extremes, and (d) facilitate recovery from impacts and extremes in order to enhance the state's resilience.

Explore cross-cutting supportive strategies. Identify governance efforts (such as leadership, policy or rule changes, procedural adjustments, etc.) and resources needed to enable the development and implementation of identified adaptation strategies.

Formalize criteria for prioritizing identified adaptation strategies. The applicability of these criteria may vary across sectors, and should ideally include but not be limited to social, environmental, equity, technical, staffing, institutional, policy, and financial/economic considerations.

Specify future direction. Indicate areas where further work will be required to increase the existing understanding of climate risks (including the possibility of catastrophic climate change), environmental and societal vulnerabilities, and adaptation options and barriers. Identify additional cross-cutting, supportive strategies such as public engagement, networking, decision support, monitoring, periodic review of adaptation effectiveness, and fundamental policy changes. Establish feedback mechanisms that provide for the modification of strategies when needed.

Provide recommendations for immediate and near-term priorities for implementing identified adaptation strategies. This may include management actions and policy changes based on the information developed in other stated objectives.

Inform and engage the California public about climate risks and adaptation strategies. Californians must be informed of existing and future climate change risks and of the need for a comprehensive approach to managing climate change risks through mitigation and adaptation. They must be provided with guidance about what actions they can initiate to adapt to climate change, or reduce their consumption of energy and resources. This information is critical, and will serve as the foundation for residents to actively engage in discussion, refinement, and implementation of those actions needed to build a climate-resilient California.

Adaptation and Mitigation: Both Needed to Manage Risks

While this effort focuses on climate adaptation, it is clear that managing impending climate risks (adaptation) must be a co-equal and integrated approach to avoiding climate extremes through reduction of GHG emissions (mitigation). While adaptation and mitigation measures are often complementary and overlapping, there may be unintended negative consequences without coordinated efforts (see Figure 4).

The changes in climate observed to date are the result of the emissions released into the atmosphere over the past several decades. Likewise, climatic conditions that will manifest 30 to 40 years from now will be the result of today's emissions. The reduction of GHG emissions is thus a priority required to minimize the long-term climate change and concomitant impacts on California's environment and society. While many GHG emission reduction efforts can produce immediate air quality improvements and cost savings, long-term climate benefits of these mitigation efforts will take several decades to become apparent. Accordingly, it is imperative to begin adaptation responses to climate change already set in motion to maintain productivity of the state's ecosystems and economy, and the well-being of all Californians.

Part II of this report examines the potential impacts on seven climate-sensitive sectors that may result from the climate changes described in this chapter. Strategies that have been proposed by CAWGs to reduce these risks and adapt to the inevitable changes are also outlined. Some strategies are applicable to multiple sectors and require cross-sector collaboration. Others require a long-term commitment.

Figure 4: *Examples of complementary and conflicting actions between adaptation and mitigation efforts.*

Complementary and Conflicting Adaptation and Mitigation Actions

Favorable Actions	⟵	⟶	Unfavorable Actions
Favorable for Adaptation and Mitigation Efforts	**Favorable for Mitigation, but Unfavorable for Adaptation Efforts**	**Favorable for Adaptation, but Unfavorable for Mitigation Efforts**	**Unfavorable for Adaptation and Mitigation Efforts**
▪ Energy Demand Management ▪ Energy Efficient Buildings ▪ Water Conservation ▪ Biodiversity-Oriented Forestry ▪ "Smart Growth" ▪ Development in Cooler Regions	▪ Forestry with Non-Native Species ▪ Urban Forestry (shade trees) with High Water Demand ▪ Some Biofuels Production	▪ Meeting Peak Energy Demand with Fossil Fuels ▪ Wastewater Recycling and Desalination ▪ Groundwater Banking ▪ Increased Air Conditioner Use ▪ Use of Drainage Pumps in Low Lying Areas	▪ Development in Floodplains ▪ Traditional "Sprawl" Development ▪ Development in Hotter Regions

Source: Bedsworth and Hanak (2008) - Reprinted with Permission by Authors

II. CALIFORNIA'S CLIMATE FUTURE

The 2009 Climate Change Projection Emissions Scenarios

To begin to assess climate change risks that Californians may be facing, it is important to first examine the changes that have already occurred.

California can draw on substantial scientific research conducted by experts at various state universities and research institutions. With more than a decade of concerted research, scientists have established that the early signs of climate change are already evident in the state – as shown, for example, in increased average temperatures, changes in temperature extremes, reduced snowpack in the Sierra Nevada, sea-level rise, and ecological shifts.[1]

Many of these changes are accelerating – locally, across the country, and around the globe. As a result of emissions already released into the atmosphere, California will face intensifying climate changes in coming decades. The state's 2009 Climate Change Impacts Assessment (the 2009 Scenarios Project) provides the scientific basis from which statewide climate impacts were synthesized for this draft adaptation strategy. The 2009 Scenarios Project examined future projections for changes in average temperatures, precipitation patterns, sea-level rise, and extreme events, as well as resulting impacts on particularly climate-sensitive sectors.[2] These scientific findings are summarized in resulting chapters to set the stage for expected impacts and California's adaptation strategies.

Generally, research indicates that California should expect overall hotter and drier conditions with a continued reduction in winter snow (with concurrent increases in winter rains), as well as increased average temperatures, and accelerating sea-level rise.[3] In addition to changes in average temperatures, sea level, and precipitation patterns, the intensity of extreme weather events is also changing. The impacts assessment indicates that extreme weather events, such as heat waves, wildfires, droughts, and floods are likely to be some of the earliest climate impacts experienced.[4] As a result, dealing with a growing number of extreme climatic events will be an important aspect of the state's adaptation to climate change.

For the 2009 Scenarios Project, a set of six global climate models were run using two emissions scenarios. These emissions scenarios are part of a family of common scenarios used by the Intergovernmental Panel on Climate Change (IPCC) in its 2007 assessment.[5] The scenarios signify plausible pathways of how global emissions may change as a result of economic, technological, and population changes over the 21st century. One scenario depicts a higher-emissions scenario (A2), the other a lower-emissions scenario (B1).[6] The A2 scenario represents a more competitive world that lacks cooperation in development and portrays a future in which economic growth is uneven, leading to a growing income gap between developed and developing parts of the world. The B1 scenario denotes a future that reflects a high level of environmental and social consciousness combined with global cooperation for sustainable development.

Anticipated Climate Changes

Temperature:
↑ 2 - 5 °F by 2050
↑ 4 - 9 °F by 2100

Precipitation:
↓ 12 - 35% by 2050

Sea Level:
↑ 12 – 18 inches by 2050
↑ 21 - 55 inches by 2100

It is important to note that these two scenarios do not bracket the entire range of possible future emissions and resulting climatic changes, as even higher emissions or lower emissions futures are possible. Moreover, it is impossible to say with scientific confidence which of the two scenarios is more likely. Thus, the IPCC has not offered probabilities (likelihood statements) attached to either of the emissions pathways. Since the IPCC's release of these two scenarios, the world has followed a "business as usual" emissions pathway, which most closely resembles the A2 scenario.[7]

While neither scenario assumes explicit climate change policies, many researchers view the B1 scenario as a “quasi-policy scenario” as it results in significantly lower GHG emissions than the “business as usual” pathway. A considerable difference emerges between A2 and B1 in the ultimate atmospheric GHG concentrations, and consequently in the degree of climate warming by the end of the 21st century (Figure 3.1).

To put these projections in historical perspective, one should consider that pre-industrial[8] concentrations of carbon dioxide in the atmosphere were about 280 parts per million by volume (ppmv). By 1960, carbon dioxide concentrations had crept up slowly to about 315 ppmv – an increase of just over 10 percent in about 200 years. The warming effect of those GHG concentrations is currently being felt. In the five intervening decades, with considerable economic growth worldwide that is fueled by the burning of carbon-based fossil fuels such as coal, gas, and oil, and extensive land use changes, there has been a staggering increase in atmospheric carbon dioxide. Recent measurements indicate global carbon dioxide concentrations in the atmosphere of 386 ppmv, a 38 percent increase over pre-industrial times.[9] The rate of annual increase of CO_2 continues to accelerate, largely determining future warming for the next few decades. In addition, other GHGs such as methane, nitrous oxide, and other gases, have dramatically increased over the last 200 years, adding to the heat-trapping effect of the atmosphere.

As Figure 3.1 illustrates, there is considerable uncertainty regarding future levels of GHG emissions due to the difficulty of predicting societal choices. It is compounded by scientific uncertainty over how the climate will respond to a given amount of GHG emissions. Global climate models also differ to some extent in how they treat atmospheric, terrestrial and hydrological processes, resulting in different levels of warming, and sometimes divergent patterns of precipitation. In the absence of better tools or methods to project future climate, the best approach is to use several climate models, driven by the same emissions scenarios, to produce a large set of model simulations. The range of simulations can then be averaged to obtain a general trend, with the spread among simulations giving a sense of the uncertainty associated with a given emissions scenario. In short, the models provide a coarse but plausible set of projections of the future, as opposed to detailed predictions.[10] For the 2009 Scenarios Project, these California-specific projections have been “downscaled” to produce regional and small-scale projections that are useful for impacts studies.

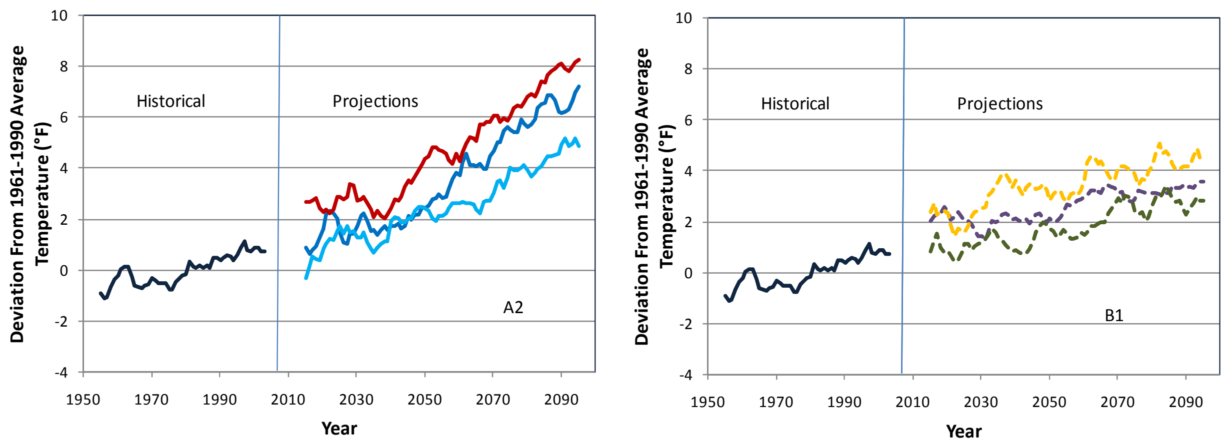
Temperature Projections

Climate change temperature projections generated for the 2009 Scenarios Project suggest the following[11]:

- Average temperature increase is expected to be more pronounced in the summer than in the winter season.
- Inland areas are likely to experience more pronounced warming than coastal regions.
- Heat waves are expected to increase in frequency, with individual heat waves also showing a tendency toward becoming longer, and extending over a larger area, thus more likely to encompass multiple population centers in California at the same time.
- As GHGs remain in the atmosphere for decades, temperature changes over the next 30 to 40 years are already largely determined by past emissions. By 2050, temperatures are projected to increase by an additional 1.8 to 5.4 °F; similar for both the A2 and B1 scenarios (an increase one to three times as large as that which occurred over the entire 20th century).
- After the middle of the century, temperature projections clearly diverge for the A2 and B1 scenarios (as a result of emissions choices made in the early part of the 21st century), with A2 projections leading to significantly greater warming. By 2100, the models project temperature increases between 3.6 to 9 °F.

All model projections for California suggest increased temperatures, with the level of emissions representing the biggest uncertainty: temperature levels will rise faster and higher by the end of this century in the A2 scenario as compared with the B1 scenario (Figure 5). These graphs starkly illustrate the dual imperative to begin adaptation now to address the impacts already set in motion, and to achieve GHG emissions reductions through global cooperation to avoid the more dramatic impacts of climate change later in the century. Stringent emission reductions now could limit climate changes and therefore allow society and ecosystems to be able to adapt more easily at a future date.

Figure 5: *Historical/Projected Annual Average Temperature for California Using three GCM's (A2 and B1 Emissions Scenarios)*

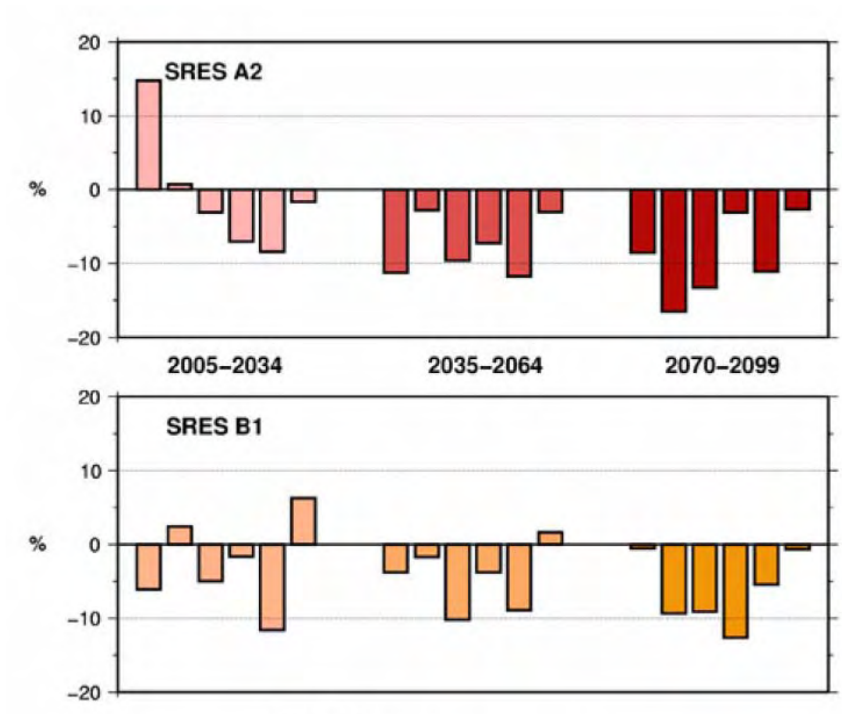


Source: Moser et al 2009, *The Future is Now*

Precipitation Projections

Current climate change projections suggest that California will continue to enjoy a Mediterranean climate with the typical seasonal pattern of relatively cool and wet winters and hot, dry summers. While precipitation levels are expected to change over the 21st century, models differ in determining where and how much rain and snowfall patterns will change under different emissions scenarios. Figure 6 shows the projected changes in northern California precipitation (the source of much of the state's water supply) relative to 1961-1990 average precipitation using six climate models with both A2 and B1 emissions scenarios. While the precipitation results vary more than the temperature projections, 11 out of 12 precipitation models run by the Scripps Institution of Oceanography suggest a small to significant (12-35 percent) overall decrease in precipitation levels by mid-century. In addition, higher temperatures increase evaporation and make for a generally drier climate, as higher temperatures hasten snowmelt and increase evaporation and make for a generally drier climate. Moreover, the 2009 Scenarios Project concludes that more precipitation will fall as rain rather than as snow, with important implications for water management in the state. California communities have largely depended on runoff from yearly established snowpack to provide the water supplies during the warmer, drier months of late spring, summer, and early autumn. With rainfall and meltwater running off earlier in the year, the state will face increasing challenges of storing the water for the dry season while protecting Californians downstream from floodwaters during the wet season.

Figure 6: *Predicted Changes in Northern California. Precipitation levels show generally drier future.*



Models used:

1: CNRM CM3 – 2: GFDL CM2.1 – 3: MIROC3.2 (med)

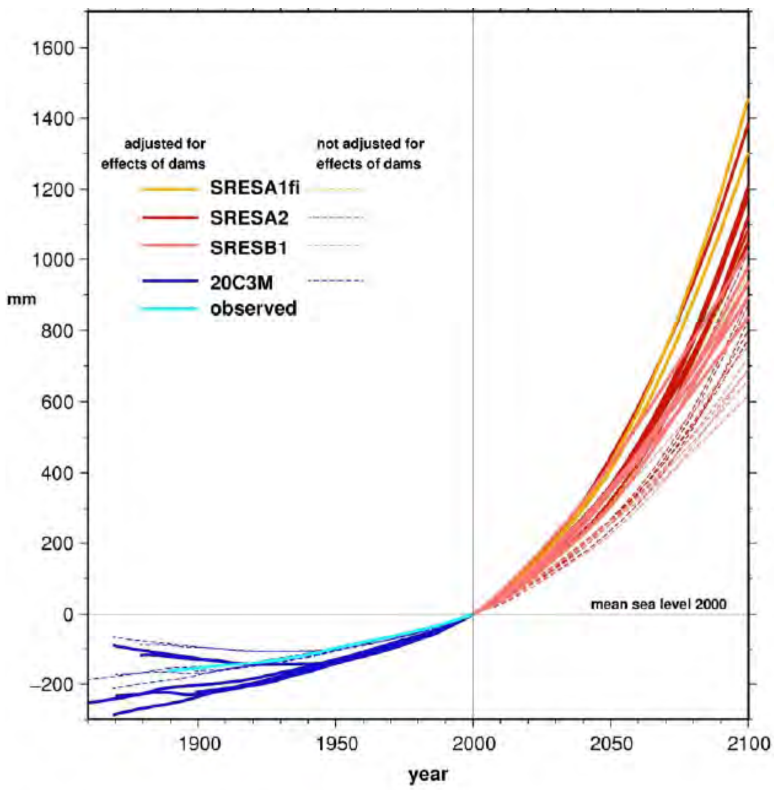
4: MPI ECHAMS – 5: NCAR CCSM3 – 6: NCAR PCM1

Source: Cayan, et al. 2009.

Sea-Level Rise Projections

Over the 20th century, sea level has risen by about seven inches along the California coast. Replacing previous projections of relatively modest increases of sea-level rise for the 21st century, the 2009 Scenarios Project built on scientific findings that became available in the last two years to produce estimates of up to 55 inches (1.4 meters) of sea-level rise under the A2 emissions scenario by the end of this century (Figure 7). This projection accounts for the global growth of dams and reservoirs and how they can affect surface runoff into the oceans, but it does not account for the possibility of substantial ice melting from Greenland or the West Antarctic Ice Sheet, which would drive sea levels along the California coast even higher. Projections of sea level rise under the B1 scenario are still several times the rate of historical sea-level rise, and would barely differ under a stringent "policy scenario" in which global emissions would be drastically reduced. This suggests that while mitigation will be important to minimize many climatic and ecological impacts, adaptation is the only way to deal with the impacts of sea-level rise during the 21st century.[12] In short, even on a lower emissions trajectory and without the addition of meltwater from the major continental ice sheets, sea levels in the 21st century can be expected to be much higher than sea levels in the 20th century.

Figure 7: *Projected Changes in Sea Level over the 21st Century*



Rahmstorf (2007) from six models 500-2009-014-D.

Source: Cayan, et al. 2009.

Projection of Extreme Events

Changes in average temperature, precipitation and sea level are significant, especially under the higher emissions (A2) scenario. Yet gradual changes in average conditions are not all for which California must prepare. In the next few decades, it is likely that the state will face a growing number of climate change-related extreme events such as heat waves, wildfires, droughts, and floods. Because communities, infrastructure, and other assets are at risk, such events can cause significant damages and are already responsible for a large fraction of near-term climate-related impacts every year.[13]

One recent study, conducted as part of the 2009 Scenarios Project, synthesized existing research to characterize the direct impacts of extreme events across different sectors of California's economy, including public health, energy, agriculture, and natural ecosystems. It also analyzed how impacts from extreme events "spill over" from one sector into other sectors and produced new projections of the future frequency and intensity of extreme events for all counties in California.[14]

Consistent with other studies, researchers found that significant increases in the frequency and magnitude of both maximum and minimum temperature extremes are possible in many areas across the state. For example, in many regions of California, the study projected at least a tenfold increase in the frequency of extreme temperatures currently estimated to occur once every 100 years, even under the moderate B1 emissions scenario. Under the A2 emissions scenario, these 100-year temperature extremes are projected to occur close to annually in most regions. Projections of precipitation extremes vary by model and downscaling method used, and expected changes tend to vary across the state. In general, however, it appears longer dry spells will become more common over the 21st century, interspersed with the occasional intense rainfall event.[15]

The July 2006 heat wave and the December 1998 freezing spell represent rather memorable extreme events in recent California history. Researchers in the 2009 Scenarios Project asked how the frequency of similar events may change with climate warming. Not surprisingly, they found that heat waves similar in length and intensity to those experienced in 2006 may become more frequent all across the state in the 21st century, with some simulations using the higher emissions scenario suggesting that such events could become *annual* occurrences by the end of this century.

In contrast, freezing spells such as that in 1998 are projected to become less frequent across the state even in locations where they are currently a yearly event. Over large portions of the state, freezing events may occur once every ten years or less by the end of the 21st century.

According to the 2009 Scenarios Project, the frequency of large coastal storms and heavy precipitation events do not appear to change significantly over the 21st century.[16] However, even if storm intensity or frequency were not to change, storms will impact the California coast more severely due to higher average sea levels that can result in higher storm surges, more extensive inland flooding, and increased erosion along the state's coastline. Future research should improve our understanding of these extreme precipitation events and their potential impacts on coastal erosion and floods.

Abrupt Climate Changes

Most climate projections developed to date, including those used in this report, produce gradual if sometimes substantial changes for a given climate variable. In the past, rapid climate changes have been observed and scientists are increasingly concerned about additional abrupt changes that could push natural systems past thresholds beyond which they could not recover. Such events have been recorded in paleoclimatological records but current global climate models cannot predict when they may occur again. Such abrupt changes have been shown to occur over very short periods of time (a few years to decades) and thus represent the most challenging situations to which society and ecosystems would need to adapt.[17]

Short of being able to predict such abrupt changes, scientists are focusing their attention on aspects of the climate and Earth system called "tipping elements" that can rapidly bring about abrupt changes. Tipping elements refer to thresholds where increases in temperature cause a chain reaction of mutually reinforcing physical processes in the Earth's dynamic cycles. The most dangerous of these include the following:

- A reduction in Arctic sea ice, which allows the (darker) polar oceans to absorb more sunlight, thereby increasing regional warming, accelerating sea ice melting even further, and enhancing Arctic warming over neighboring (currently frozen) land areas.
- The release of methane (a potent GHG), which is currently trapped in frozen ground (permafrost) in the Arctic tundra, will increase with regional warming and melting of the ground, leading to further and more rapid warming and resulting in increased permafrost melting.
- Continued warming in the Amazon could cause significant rainfall loss and large scale dying of forest vegetation, which will further release CO_2.
- The accelerated melting of Greenland and West Antarctic Ice Sheets observed in recent times, together with regional warming over land and in the oceans, involves mechanisms that can reinforce the loss of ice and increase the rate of global sea-level rise.

The temperature increases that could trigger these chain reaction events are still the subject of research, but estimates range from 1 to 3 °F of additional warming for widespread, rapid (10 year) Arctic sea ice melt; 2 to 4 °F for irreversible melting of the Greenland Ice Sheet (over the next 300 years or more); 5 to 9 °F for the irreversible melting of the West Antarctic Ice Sheet (also over 300 or more years), and 5 to 7 °F for Amazon forest die-back. Should these thresholds be crossed in the coming decades, the Earth's sea level would be on an irreversible course destined to rise 7-12 meters (as much as 23-40 feet) over the course of several centuries—a rate not seen in human history.[18]

Another tipping element that could have a significant effect on California's long-term climate variability is the potential intensification of the El Niño Southern Oscillation (ENSO) cycles over the Pacific Ocean. ENSO is one key factor in California's wet year and drought year cycles and intensification would mean stormier wet years and even drier (or extended periods of) drought years. It would also mean more severe coastal storms during the winter months and hence more erosion and coastal flooding. Current research indicates that a tipping point of 6 to 11 °F could trigger this intensification of ENSO cycles.[19]

III. Comprehensive State Adaptation Strategies

Cross Sector Collaboration

Navigating the complex science and policy needs related to reducing California's vulnerability to future climate impacts will require an unprecedented level of collaboration and leadership. Most state sectors and departments leading climate adaptation strategy development share management responsibilities, have overlapping jurisdictions, and in many instances, depend upon one another to accomplish their organizational mandates. Through the development of the *2009 California Climate Adaptation Strategy Discussion Draft*, the primary need identified by all sectors and most stakeholders is to improve coordination within state government.

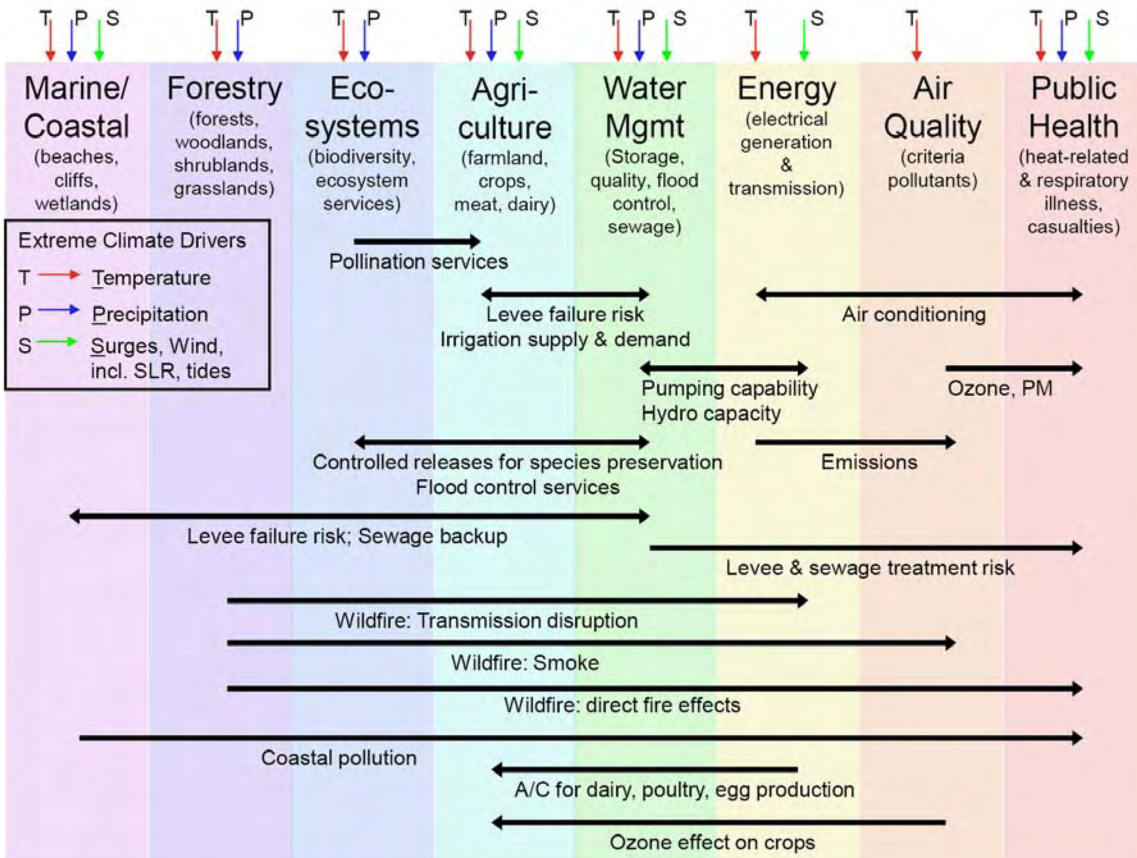
Reducing sea level rise risks provides one example of the need for cross-sector collaboration. The state, recognizing this as a global issue, prefers that all agencies work together from an agreed upon reference point from which to coordinate their approaches to sea level rise impacts. Currently, various state agencies have different policies and regulations requiring consideration of and adaptation to sea-level rise. These agencies are working with best available scientific information to continue executing their ongoing responsibilities, but the lack of coordinated state-wide estimates of future sea-level rise can create confusion and uncertainty among stakeholders, waste money through duplicative efforts, and potentially reduce attention toward more vulnerable locations. Ongoing agency work related to climate change and adaptation cannot come to a standstill until there is an agreement on all climate science or adaptation measures, however, it makes sense to work towards a central location in state government responsible for developing broad-based state policies for adaptation based on peer reviewed science and impact assessments of sea level rise, identifying areas most vulnerable, and developing policies to reduce these vulnerabilities. Coordinated efforts for sea level rise, and all climate impacts, could increase overall awareness of climate change, develop shared stewardship concerns, prioritize the efficient use of resources and expertise, streamline interagency permitting processes and prevent or reduce the possibility of unintended consequences.

Figure 8 highlights the inherent need to approach climate adaptation through exposing how climate dependent circumstances integrate across sectors. Accordingly, the state will need to work across all levels of government and sectors to address the interconnected nature of these issues to accomplish many of the large scale strategies. For example the protection of migratory habitat corridors for species adaptability between ecosystems will need to be coordinated across all level of governments with the help of private property owners. Also, assistance from every sector is needed in fixing and sustainably managing the state's future water supply and demand, and to improve our understanding of how climate change will alter this delicate balance.

California's efforts to develop a statewide strategy are part of a dynamic state, national, and federal policy environment that is progressing in a largely independent manner. Concurrent, uncoordinated planning is inevitable as climate change impacts are felt locally but state actions that begin to coordinate climate adaptation efforts can help minimize short and long term financial costs, threats to humans, and reduction of habitat and species.

This chapter identifies comprehensive state adaptation planning strategies based on their ability to bridge efforts across state strategies. Strategies are prioritized based on their ability to reduce financial and resource inefficiencies through collective action and on the level of importance to individual sectors. Subsequent chapters of this report focus on sector specific strategies.

Figure 8: *Extreme Climate Drivers and Inter-Sector Interactions*



1) Promote Comprehensive State Agency Adaptation Planning

The *Draft Climate Adaptation Strategy* was developed under direction from Governor Schwarzenegger within Executive Order S-13-08 to complete the state's first comprehensive strategy. To continue the implementation of this strategy over time, climate adaptation needs to be institutionalized into state planning processes, budgets, and policy development. This will require continued state leadership with a central coordinating body. Currently, the CNRA has been coordinating climate adaptation efforts, as stated in the Governor's order and instituted within the CAT.

Implementing the strategies within this report will require resources for each department and agency leading strategy efforts to implement sector-specific and comprehensive state agency planning efforts. This leadership and commitment is necessary to ensure collective state resources are not wasted on uncoordinated adaptation strategy efforts, and to ensure policy-makers are focused on using the latest scientific understanding to inform climate adaptation policy development.

State coordination should also ensure linkages and collaboration among scientists and decision-makers to ensure the best research is utilized, and key research gaps are identified.[1] This is already taking place through the Energy Commission's Climate Change Center. This should also occur as part of a university system-wide Climate Change Adaptation Research Center, all coordinated under the CAT effort to facilitate decision support that could fill research gaps and offer sectors the opportunity to utilize the expertise concentrated at university campuses. For example, adaptation centers have already begun at Stanford University; the University of California, San Diego; the University of California, Berkeley; and many others within California. Using the information and processes identified in this report, these centers should coordinate to rapidly build the state's scientific foundation in vulnerability and adaptation. These centers should also focus on providing this information to local governments and the private sector, thereby providing effective guidance and decision-support tools for adaptation implementation.

Climate adaptation strategies are beginning to be mainstreamed into relevant planning (i.e., environmental impact assessments), budgeting and operations management, but more work is needed. Many agencies have already made climate change a central focus of their policies and plans, while others have just begun to implement plans or actions. For example, water agencies are required to plan for climate variability inherent in California's Mediterranean, semi-arid and drought-prone precipitation patterns. Coastal agencies consider sea level rise in their planning processes but are now grappling with ways to address the accelerating rates of climate change and uncertainty of future conditions that are now anticipated. All agencies responsible for the management of California's natural resources have an opportunity to mainstream adaptation given current climate-related hazards and the sensitivities that they currently face. The state should eventually provide support and funding for comprehensive adaptation planning by all state agencies where significant vulnerabilities and hazards are identified.

In these times of budget challenges in California, it should be noted that new responsibilities will be required of state agencies to implement an effective adaptation strategy and many will need additional resources for full implementation. Local communities will also be challenged in implementing many adaptation measures where most of the implementation work for adaptation will take place at the county and city level. Communities will likely also need additional funding and resources to update general plans and incorporate new policies related to climate change.

STRATEGY 1: Establish a centralized entity for coordinating and developing all state climate adaptation policies, vulnerability analysis, research, and public outreach in coordination under the Climate Action Team.

Given the current state budget situation, these efforts will need to be continued with existing agency staff resources. As these efforts become more comprehensive, however, development of a California Climate Adaptation Office is recommended to complete the following: (a) develop coordinated state-wide climate adaptation policies in coordination with all state agencies; (b) coordinate climate change adaptation-specific research and collaborate with the CAT in applying and receiving state federal research funding; (c) be responsible for coordinating, developing, maintaining and updating a State Climate Change Vulnerability Report summarizing California's vulnerability to climate change; (d) develop a public outreach campaign around climate change adaptation; and (e) be responsible for developing adaptation tools to help public and private stakeholders reduce their climate risks. The California Natural Resources Agency will continue to coordinate state adaptation efforts with all state agencies and Departments involved in the development of the CAS, but a coordinated office will require multi-agency commitments and dedicated staff and resources linked to a central office.

2) Integrate Land Use Planning and Climate Adaptation Planning

Land use decisions are a central component of preparing for and minimizing climate change impacts. In order for California to succeed with its adaptation strategies, local and regional governments and local and regional planning efforts must be integral parts of the adaptation process.

Many, if not most, land use decisions in California are made at the local level and increasingly at the regional level. Decisions made by cities and counties through general plan and local planning processes direct local land uses. Given the long-range view of general plans, cities and counties should consider how a changing climate and environment will affect nearly all aspects of general plans and long-term development.

Through the implementation of Senate Bill 375 (Steinberg; Chapter 728, Statutes 2008) Metropolitan Planning Organizations (MPOs) will have greater influence on planning efforts and outcomes at the regional and local level. Regional Transportation Plans developed through a "Sustainable Communities Strategy" will have to take into account GHG reduction measures related to land use and transportation, identify the general location of uses, residential densities, and building intensities within the region and identify areas within the region sufficient to house all the population of the region. The state plays a role in local development patterns through the development and funding of the state transportation system, the siting requirements for school facilities and other infrastructure projects, and funding mechanisms.

Decisions made by water districts, resource management districts, flood control districts, school districts and many others will also need to take into account the probable impacts associated with climate change. Local Agency Formation Commissions, Metropolitan Planning Organizations and Councils of Governments will all need to consider the impacts of climate change when making decisions that impact land use and development patterns.

Community development decisions can affect all sectors. Development decisions along the coast, in floodplains or at the wildland-urban interface will impact the ability of the state to adapt to climate change impacts. Decisions related to urban forestry, the connectivity of biological reserves, and the routing of roads and other infrastructure also play a role in implementing state adaptation strategies. Local land use planning should be cognizant of the growing risks from climate change as well as the land-use related needs to implement effective adaptation strategies. To the extent local land use is coordinated with regional, state and federal adaptation strategies, impacts from climate change are likely to be minimized, and in turn have less significant effects on local communities. The long-term vision and development goals of general plans should therefore address climate change as soon as possible. Coordination and consultation mechanisms need to be established or strengthened to ensure local, state, and other jurisdictions do not work at cross-purposes (see cross-jurisdictional coordination above).

Many local development decisions (ex: type and location of development in key areas) can negatively or positively affect the success of climate adaptation efforts. Accordingly, the state will need to work across all levels of government to accomplish many of the large scale strategies. Local plans, ordinances, regulations, and the siting of structures will need to take into account the probability of increased events such as wildfires and floods. Communities on the coast should consider the impact sea level rise will have on infrastructure, housing, natural resources, and public safety. General plans can take this into account as part of the land use, safety, conservation and open-space elements. In order to accurately address the vulnerability, resilience, and future growth of areas prone to climate change impacts, a city or county should take three distinct steps:

First, cities and counties should use information provided by state and federal agencies about where climate change could impact the human and natural systems including risks affecting public safety and emergency response. These could be used to focus local planning on areas vulnerable to climate change impacts such as floodplains, coastal areas, and fire hazard areas. Critical infrastructure such as roads, power lines, and water/wastewater pipelines that may be affected by climate change should be identified. Second, planning organizations should recognize climate impacts that may affect federal, state or local parks, as these systems offer valuable recreational opportunities critical to the well being of all communities. Third, sources of water that may be reduced by increased temperatures should be identified.

Once these potential areas have been identified, cities and counties should focus, when appropriate, on areas that are particularly vulnerable to climate change. Using the best available resources, local governments should note which areas can or cannot withstand changes in sea level, water use, temperature, and other climate change impacts. Areas that cannot withstand changes can be prioritized by potential safety risks, potential biological or natural impacts, or other factors. The local government should determine which areas will need the most attention to avert these risks. The *2009 California Climate Adaptation Strategy Discussion Draft* can be a valuable resource in making these determinations if effective adaptation planning tools are continually developed.

There are a number of ways to address climate change impacts. For future land use decisions, general plan amendments may be needed. Safety risks may be outlined and mitigated in a Local Hazard Mitigation Plan. To address public infrastructure, a public works plan may be needed. A climate action plan may be used to prioritize actions that are immediately needed and which actions can be implemented over time.

One tool that has been successful in helping to bring together many levels of government to look at long range planning on the regional and local scale is the California Regional Blueprints Program. Through the development of scenario-based integrated plans, regions and local governments can develop different planning scenarios that achieve a variety of objectives and goals, including GHG reduction and climate change adaptation. The blueprint planning process is an important tool MPOs can use to meet SB 375 requirements and develop their Sustainable Communities Strategies. Further, the blueprint planning process can help identify areas vulnerable to climate change and identify ways to address those vulnerabilities in an integrated and comprehensive manner.

As the state works to meet its GHG reduction goals, adapt and plan for climate change impacts, and restore the economy, the entire state, including all levels of government, non-profits, businesses, private property owners and the general population, should, when appropriate, evaluate how and where critical infrastructure is developed, what types of structures are allowed to be built in certain locations, and how to best protect natural resources.

STRATEGY 2: To improve links between land-use planning and climate adaptation planning, cities and communities should address climate change impact risks in their General Plans (i.e., identify climate change impacts, identify areas most vulnerable to these impacts, and to develop risk reduction strategies using the State strategy as guidance) and the state should use the California Regional Blueprint Program to better integrate adaptation strategies into blueprint plans.

3) Improve Emergency Preparedness and Response Capacity for Climate Change Impacts

Even with the best adaptation efforts, not all risks are preventable. As climate change is likely to increase the frequency and in some instances the intensity of extreme events (i.e. heat, drought, flooding, or fires), agencies must periodically review their changing capacity needs. As catastrophic events become more frequent and each draws heavily on private and public resources, every effort must be made to avoid or minimize exposure to these extremes, so as not to overwhelm emergency response capacity.

While it is more effective and less costly to engage in anticipatory planning (prevention and preparation), it is also important to limit the consequences of unforeseen yet inevitable extremes (response, hazard mitigation). Additionally, all sectors with resources or operational processes at risk from climatic extremes will need to build their level of preparedness, emergency response capacity, and ability to facilitate rapid and climate-cognizant recovery.

Contingency and emergency planning provides an enhanced capacity to respond to the immediate impacts of extreme weather events at an accelerated rate. When coupled with long-term planning, enhanced emergency preparedness can build adaptive capacity. Further, a sustained hazard mitigation effort will reduce the impacts of these climate change impacts. This constitutes a proactive strategy for addressing impacts and forms a strong foundation for all phases of adaptation planning (mitigate, prepare, respond, recover).

Effective emergency response to climate impacts will require unprecedented coordination across all service levels. Strategic planning efforts will need to include contingencies for tiered responses to a given impact, depending on level of severity. A flood or heat wave with only local impacts, for example, would be handled by municipal emergency response services. Responses to more serious events would trigger county, state or even federal-level assistance. While emergency systems are already coordinated under the Standardized Emergency Management System (SEMS), there are no comprehensive emergency response planning efforts that consider the widespread and recurring nature of climate-driven impacts.

An equally important component needed to support this level of coordination during emergencies is access to easily accessible information required for inter-organizational real-time planning. With the potential scale of impacts resulting from climate change, informational tools for immediate, accurate and accessible situational awareness will be essential. This requires improving information systems as well as developing planning tools to better manage the increased frequency of emergencies under climate change.

The need to plan for climate impacts before they happen is important; not only with effective and coordinated response, but also proactively when making land use planning decisions. Examples include avoiding development in potential flood zones, core habitat reserve areas, and areas prone to wildfires that will occur as a result of these climate changes. The increase in hazard areas due to climate change will put a strain on emergency services as the impacts become more commonplace in these expanded hazard areas.

To address these issues, OPR in cooperation with the CNRA and its constituent departments will link with efforts to update the State Emergency Plan, and the State Hazard Mitigation Plan, to strengthen consideration of climate impacts to hazard assessment planning, implementation priorities, and emergency response. This is important in the potential to qualify the state for additional federal funds that would be needed given the shorter duration between impacts under climate change. The CNRA and OPR will attempt to build on existing information tools as they relate to climate impacts and on required public safety plans, such as the State Fire Plan, through coordination with CERES at the state level, and FEMA at the federal level. Potential funding of these efforts through FEMA will be explored.

STRATEGY 3: The California Emergency Management Agency (Cal EMA) will collaborate with CNRA and the seven sector-based Climate Adaptation Working Groups (CAWGs) to assess California's vulnerability, identify impacts to State assets, and promote climate adaptation/mitigation awareness through the Hazard Mitigation Web Portal and My Hazards website as well as other appropriate sites. *Climate change impacts were recognized in the 2007 State Hazard Mitigation Plan (SHMP) as having an effect on primary hazards such as flooding and wildfires and secondary hazards such as levee failure and landslides. A more refined understanding of the impacts of climate change will be forthcoming during the next three-year SHMP update cycle in 2010. Special attention will be paid in the overall assessment on the most vulnerable communities impacted by climate change.*

4) Expand Research and Monitoring for State Climate Change Risks and Regularly Assess Progress on Actions to Reduce Risks

The most critical challenge in managing climate change risks is the need for new and expanded climate research and monitoring that can drive policy decisions in a timely way. As planners, land managers and conservation practitioners need results from climate change research to make effective decisions, state conservation agencies should work with the research community to identify methods of making research results more timely. Research and monitoring are needed at all levels of government to allow policy-makers to identify what impacts will happen where and in what timeframe. However, even as research continues to expand, decision-makers will have to make decisions in a world with increasing uncertainty regarding climate changes. Establishing systems that monitor these changes, such as through regular climate adaptation efforts, will allow pubic and private sector entities to better incorporate these changes into decision-making and financial decisions.

California has already initiated an esteemed research effort through the Energy Commission's Public Interest Energy Research (PIER) Program, highlighted in Chapter 2, that serves as the scientific foundation for this draft adaptation strategy. As climate science improves, more questions are being raised, requiring further detail and analysis. Figure 9 provides a list of climate adaptation research questions raised by the state climate research coordination committee outlined in the 2009 CAT report and show the depth of information needed to better inform policy efforts. Other issues not specifically addressed in this table include the need to better coordinate future "top down" climate change scenario work, with “bottom up” studies showing sector specific changes as was done recently by the Department of Water Resources for the water sector. In addition, more detailed economic analysis is needed to show the long-term costs and benefits from both taking action and doing nothing to slow the state’s vulnerability to climate change. The economic studies should be merged with the climate mitigation economic studies currently being developed by the California Air Resources Board.

Monitoring existing climate changes is as important as modelling future changes. Unfortunately, California’s existing monitoring network was not established with climate change in mind. Temperature monitoring states are based on areas where people and resources exist instead of locations that could act as an “early warning system” of greater climate change to social, environmental and economic

Figure 9: Sample Climate Adaptation Research Needs (2009 CAT Report)

- *Heat Waves and Public Health*
  - The relationship between temperature, air pollution episodes, and health endpoints, to protect vulnerable subgroups;
  - Changes in atmospheric chemistry that change human pollution exposure;
  - Differential risk to populations vulnerable due to physiological, socioeconomic, or occupational factors.
- *Energy supply, demand, and delivery*
  - Availability of energy resources and fuels
- *Wildfires*
  - The increased risk of wildfire impacts on natural resources, sensitive species and habitat
  - The types of human health conditions and priority interventions for sensitive populations
- *Sea level rise*
  - Analytical techniques to evaluating coastal storm surge and flooding.
  - Development and evaluation of effective sea level rise adaptation strategies to minimize impacts to coastal development and ecosystems.
- *Ecosystem Impacts*
  - Development of tools to forecast species’ responses to climate change
  - Identification of critical connections/corridors taking into account alterations due to climate change
  - Forest management techniques to promote ecosystem health and resiliency
  - Establishing adaptation measures designed to reduce at-risk species and protect biodiversity;
- *Floods and Droughts*
  - Prediction of storm events with the potential to generate major regional flooding;
  - Increases in risk of flooding and repeated drought/flooding cycles due to extreme variability in rainfall patterns and more-rapid spring snowmelt,
- *Air quality/respiratory health*
  - The relationship between predicted ecological shifts and the potential for increased pollen production.
- *Community design and land use*
  - Assessment of how land-use decisions influence the amount of GHGs generated by a community and affect local climate;
- *Health behaviors/communication*
  - The policies/incentives that encourage more walking, bicycling, and use of public transportation;
  - Ways to incorporate health impact assessments into land use planning.
- *Surveillance*
  - Determining key environmental and health indicators that need to be monitored on an ongoing basis for trends in the effects of climate change on human and ecosystem health.
- *Mapping*
  - GIS mapping capability to identify regions and populations most vulnerable to climate change impacts
  - High resolution mapping in coastal and bay regions to support sea level rise vulnerability assessments and evaluation of adaptation options
  - Vegetation mapping to track changes in distribution and condition, including pest and disease trends
- *Market development and commerce*
  - Ways to fund and incentivize adaptation mitigation efforts for protecting biodiversity and maintaining ecosystem services
  - Adaptation measures that promote economic well-being co-benefits

systems. For example, expanded surveillance of pests, invasive species, or disease vectors could identify where crops or populations that are most vulnerable and provide lead times to develop new pesticides or vaccines.

Data management is also a key component of improving climate risk information. Centralized data banks with easily accessible formats that synthesize data for land and resource managers and other officials would greatly enhance the usability of this information. For example, myhazards.calema.ca.gov is a great example of how synthesizing research, monitoring, maps, and policy tools provides the public with comprehensive information on natural disaster risks, and tools to reduce these risks, in their area. The integration of information collected from state, federal, local, academic, and non-governmental organizations (NGO) sources could rapidly expand available data bases, fill data gaps, and increase efficiencies when it is shared and not proprietarily protected. This need for a centralized, comprehensive online resource for locating the latest climate research and monitoring has been identified but not yet fully realized due to budget and resource constraints. The CAT climate research coordinating sub-group should follow through to augment the existing California Climate Change Portal to centrally manage this information.

Finally, it is critical to measure the success and effectiveness of adaptation strategies. The assignment of specific performance measures to each strategy and sub-strategy within the *2009 California Climate Adaptation Strategy Discussion Draft* should be developed by January 1, 2011. Scientifically verifiable and broadly agreed-upon performance measures will support agencies to make defensible budget requests supported by past achievements.

STRATEGY 4: Expand Research and Monitoring for State Climate Change Risks and Regularly Assess Progress on Actions to Reduce Risks - *The State Climate Change Action Team Research Sub-Group will develop a strategic plan by September 2010 that will identify: priority state climate adaptation research and monitoring needs; proposed resources and timeframes to implement the plan; and potential for research co-funding and collaboration with local, state, and national agencies, universities and other research institutions. The CAT Sub-Group should develop a comprehensive research project catalog and continue to biannually publish key state sponsored climate research on the California Climate Change web-portal.*

5) Develop a Climate Change Vulnerability Assessment

California's current climate impact vulnerability information is based on peer reviewed science that is continually improving and being refined to scales that will be more informative and useful for planners and managers. This draft adaptation strategy was developed using the "hazard-based assessment approach" (explained in Chapter 2), which is useful, but limited in the information it can provide to inform policy direction. Now, California should move toward developing a "vulnerability assessment approach" that quantifies the probability that certain consequences under different future climate scenarios will occur, and identifies the resulting vulnerabilities. A vulnerability assessment integrates the risk (i.e., the probability of certain consequences occurring) with the likely sensitivity and response capacity of natural and human systems that are at risk of experiencing these consequences. This requires several steps beyond what is presented in this report including: (1) further research to identify the probability and resulting risks of the existing climate scenarios and resulting consequences; (2) link policy-makers with climate scientists to identify adaptation policy options and barriers, along with costs and benefits, to best reduce and manage the identified risks; and (3) a broad pubic stakeholder process to communicate the options available to reduce climate risks and to work toward a prioritization of where the state should focus its limited resources in implementing priority strategies.

A key motivation for completing a vulnerability assessment is to identify and help the most vulnerable communities, populations, sectors, and natural systems. For example, Gleick et al. (2008) reports that up to 500,000 low–income individuals in "communities of color" are vulnerable to future sea level rise in the San Francisco Bay Area. This raises important political and economic questions regarding how the state plans to mitigate future climate change impacts. Answers will require difficult trade-offs and require significant input stakeholders ensuring environmental justice concerns are adequately addressed.

All sectors engaged in the development of the 2009 California Climate Adaptation Strategy Discussion Draft recognize their obligation to work closely with all stakeholders and that environmental justice concerns should be incorporated and mainstreamed into all strategies where it is possible. It is also necessary to ensure climate adaptation strategies can assist toward the greater goal of ensuring all California residents have the opportunity to live, learn, and work without regard to race, age, culture, income, or geographic locations.

State agencies should interact with California Indian Tribes respectfully and on a government-to-government basis. Because traditional knowledge will have a role in combating climate change, indigenous communities should be involved in climate change adaptation actions that will directly impact their people, waterways, cultural resources, or lands; all of which are intimately associated.

In the near term, state agencies should continue working together within the CAT *Research Sub-Group* to coordinate policy responses based on the Energy Commission's climate scenarios research, and to build upon sector-specific research and monitoring activities. At a minimum, each sector and responsible agency and department should use this research to assess how climate changes will impact their mission and what steps will be needed to adapt policies and procedures to meet those challenges.

STRATEGY 5: Develop a statewide and sector specific California Climate Vulnerability Assessment (CCVA) to ensure the best available and comprehensive science informs climate adaptation decision making. *State agencies will work through the CNRA initially, and eventually through the State Climate Change Adaptation Office, to develop the state's first CCVA focused on sharing information, providing opportunities for public discussion on climate risk research and policies, and developing cross-sector strategies. The CNRA with assistance from the Energy Commission, the California Emergency Management Agency (CalEMA), the CAT research group, and other affected agencies will secure funding and develop a scientific framework for the CCVA. The development of a CCVA will include public outreach to prioritize risk reduction strategies and will be completed by January 1, 2011 (depending on contracting and funding this study by January 1, 2010). The final CCVA will allow policy-makers the ability to develop a more systematic approach to funding risk reduction efforts. Every effort will be paid to identify and assist those communities expected to be most at risk from future climate change.*

6) Develop a Climate Change Impact and Adaptation Strategy Outreach Campaign

There is growing understanding that climate change is happening now and that human induced GHG emissions are to blame. Unfortunately, there is less public knowledge of current and projected climate impacts, who and what systems are at greatest risk, and the actions necessary to reduce these risks. This is partly due to the rapidly changing information, but also about the lack of a state-coordinated public outreach effort to inform the public about *how* to reduce climate-related risks.

A public outreach and educational campaign is needed to communicate information about climate change impacts and risk reduction strategies. A well-developed campaign could not only work to ensure transparency in decision-making, but can potentially change behavior. For example, improved information and tools regarding future sea level rise risks could better inform vulnerable coastal communities to reduce development and/or build sea walls around vulnerable areas based on the best available climate research saving the community (and the state) future emergency management capital outlays.

The CNRA has taken steps throughout the adaptation planning process to increase public outreach and stakeholder participation with regard to climate adaptation strategies. The California Climate Change Portal (www.climatechange.ca.gov/adaptation) provides a readily accessible tool for communicating the state's work to tackle climate change. California will increase use of this site as it develops this draft adaptation strategy so that stakeholders have the ability to track development and integration of climate policies.

The ultimate success of an outreach campaign is based on providing information and tools to the public that can be used to reduce the state's vulnerability to climate change. California is in the process of developing two tools as part of this report including a Web-based map that will show climate impacts based on PIER research efforts, and a climate adaptation protocol that will allow communities to follow a simple process to understand where they are most vulnerable to climate change and how to reduce potential risks.

The interactive climate change impact Web-based map is in development and will use a popular Web portal to communicate climate change impact information in a user-friendly format. If successful, individuals will be able to view regional temperature, sea level and precipitation projections. Ideally, this information will be linked with the state natural hazard interactive map (myhazards.calema.ca.gov) with the goal of localizing all natural hazard information.

Similarly, local communities need a state-sponsored method for assessing their vulnerability to climate change and simple list of climate impact mitigation measures to reduce these risks. A climate adaptation protocol would link existing, or develop new, simplified climate vulnerability assessment tools similar to the Local Government Protocol adopted by the Air Resources Board in partnership with the California Climate Action Registry, the Climate Registry and Local Governments for Sustainability (ICLEI). This will be dependent on securing additional support to implement this measure with stakeholders.

Finally, training state and public stakeholders on both climate impacts and risk reduction strategies will be necessary to implement an effective adaptation strategy. State agencies and other institutions must develop internal subject expertise as the need for adaptation increases. Personnel should be encouraged by managers to learn about climate change, vulnerability and adaptation, and become more proficient in integrating knowledge from different sectors and disciplines. This requires ongoing support to participate in training, education and networking opportunities. Internal capacity building should enhance staff's understanding related to climate change in terms of understanding vulnerabilities, identifying and implementing adaptation strategies, and developing indicators to assess the efficacy of chosen policies and management actions. Other proactive efforts should include in-house training, conference trainings, recruitment of employees with climate-related expertise, climate-specific job classifications, revised duty statements, assessments of organizational climate policies, and increased access to researchers and consultants that provide greater climate understanding, modeling analysis and improved scientific knowledge. This will fundamentally enhance the internal professional capacity for staff and managers at all state agencies.

Climate change awareness will aid in the mobilization of Californians to begin planning for impacts, thereby increasing resiliency and reducing potential harm. It will also serve to encourage communities to prepare for climate change; and provide resources to California's residents to enable them to better prepare at home and in the workplace. This is a very important component of adaptation planning because all Californians must participate for adaptation to succeed.

STRATEGY 6: Develop a Climate Change Impact and Adaptation Strategy Outreach Campaign - *Develop a coordinated climate change adaptation outreach effort building on the existing California Climate Change Portal (climatechange.ca.gov) that will communicate climate change science and impact information, clearly communicate how State strategies and all stakeholders can take action, and develop a series of tools to reduce the state's vulnerability to climate change. Tools will include the development of a Web-based map that will allow any individual to assess climate impacts and strategies for their region, and a climate adaptation protocol (depending on available resources) to allow communities to initiate a preliminary screening for climate risks.*

PART II:

CLIMATE CHANGE - IMPACTS, RISKS AND STRATEGIES BY SECTOR

In this first effort to develop an approach for statewide climate adaptation planning, state agencies were organized into resource-based sector working groups. These working groups were tasked with assessing climate impacts to their respective resource areas based on the PIER research-based statewide impacts (see “California’s Future Climate”), and identifying preliminary adaptation strategies organized by the necessity and/or ability to implement short term (by January 2011) and longer term. As these working groups stem from differing resource management issues, there is variability in the applied long-term climate adaptation planning horizon (50, 75, 100 years). The following sections focus on each sector, respectively:

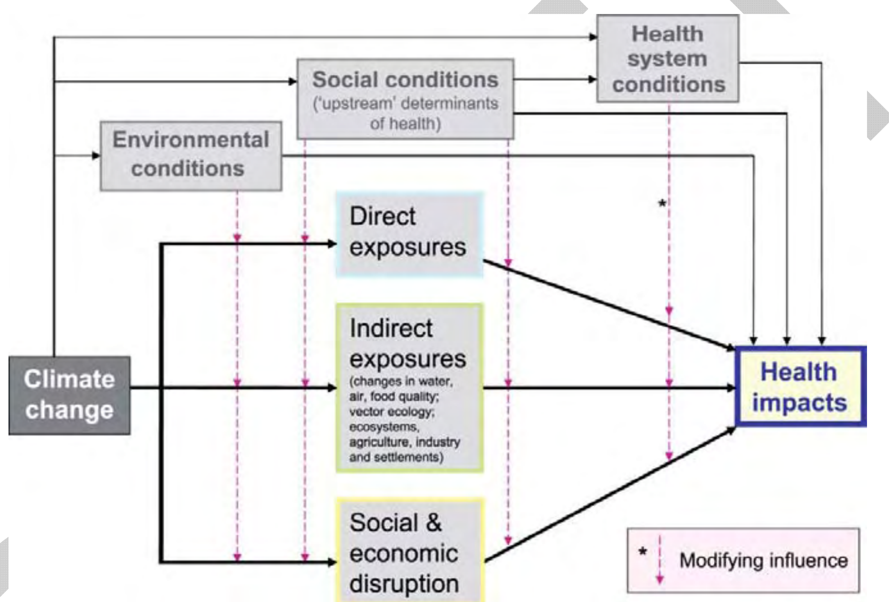
- Public Health
- Biodiversity and Habitat
- Oceans and Coastal Resources
- Water Supply
- Agriculture
- Forestry
- Transportation and Energy Infrastructure

IV. PUBLIC HEALTH

Introduction

Climate change can potentially threaten the health and well-being of all Californians through a variety of exposures and environmental changes. For example, more severe extreme weather events, a decline in air quality, increases in allergenic plant pollen, more frequent wildfires, and altered environmental conditions that foster the spread of communicable and vector-borne diseases. Climate change also threatens the basic life supports on which humans depend – our water, food, shelter and security. Among the segments of the population that are at greatest risk include the elderly, infants, individuals suffering from chronic heart or lung disease, persons with mental disabilities, the socially and/or economically disadvantaged, and those who work outdoors.

Figure 10: *Flow diagram showing inter-relationships of climate impacts to conditions affecting public health.*



Climate adaptation offers opportunities to find strategies with co-benefits for public health and mitigation. For example, reducing vehicle miles traveled will increase physical activity and reduce obesity and chronic disease. Five chronic diseases - cancer, diabetes, cardiovascular disease, stroke, and chronic obstructive pulmonary disease - account for two-thirds of all deaths in the United States.[2] By 2020, 50 percent of Americans will be living with a chronic illness.[3] California's aging population will require more care for chronic illnesses. It is estimated that 87 percent of Medicare beneficiaries have at least one chronic illness.[4] By 2030, it is expected that 20 percent of Californians will be age 65 and older; the large majority of which will have one or more chronic diseases. Older adults, even those without diagnosed chronic disease, appear to be especially susceptible to many of the health challenges posed by climate change.

Future Climate Change Impacts to Public Health

A. Increased Temperature and Extreme Weather Events

Climate change is expected to lead to an increase in ambient (i.e., outdoor) average air temperature, with greater increases expected in summer than in winter months. Larger temperature increases are anticipated in inland communities as compared to the California coast. The potential health impacts from sustained and significantly higher than average temperatures include heat stroke, heat exhaustion, and the exacerbation of existing medical conditions such as cardiovascular and respiratory diseases, diabetes, nervous system disorders, emphysema, and epilepsy.[5] Numerous studies have indicated that there are generally more deaths during periods of sustained higher temperatures, and these are due to cardiovascular causes and other chronic diseases.[6] The elderly, infants, and socially-isolated people with pre-existing illnesses who lack access to air conditioning or cooling spaces are among the most at risk during heat waves.[7]

PUBLIC HEALTH AND ENVIRONMENTAL IMPACTS DUE TO WARMING

- Higher Rates of Mortality & Morbidity
- Increased Air Pollution
- Seasonal Changes & Increases in Allergens
- Changes in Prevalence & Spread of Disease Vectors
- Possible Decrease in Food Quality & Security
- Reduction in Water Availability
- Increased Pesticide Use

Extreme Heat Events

There is no universal definition of an extreme heat event (i.e., heat wave) since it depends on the locale, but in most parts of the U.S., three days over 90 degrees Fahrenheit is considered a heat wave. Various other useful meteorologically-defined indicators of a heat wave have been developed. For example, extreme heat events can be defined as temperatures that rise to the highest 10 percent of all temperatures that were recorded during the summer months from 1961-90 in a given locale.[8] Climate change is expected to lead to increases in the frequency, intensity, and duration of extreme heat events and heat waves in California.[9] Heat waves can be characterized by above-normal averages, or maximum daily temperatures, which may be accompanied by higher nighttime minimum temperatures.[10] There is evidence for a trend in heat waves in California to have higher nighttime (i.e., higher minimum) temperatures as compared with the historical record, with daytime maximum temperatures being more similar to past heat waves.[11] This has important implications as there is less chance for people to physiologically recover and cool off, and for the built environment (indoors or outdoor) to cool, contributing both to continued heat stress overnight and compounding the effects of

ADAPTATION - COUNTY OF SONOMA HEAT WAVE GUIDELINES:

- **Drink** - Drink plenty of cool fluids.
- **Dress** - Wear lightweight, light-colored, loose-fitting clothing. If outdoors, wear a wide-brimmed hat, sunglasses and sunscreen. **Decrease** - Limit physical activity and stay indoors in an air-conditioned space (home, library or shopping mall). If an ***extreme heat event***, listen to the radio for the location of emergency cooling centers.
- **Defend** - If working outside, monitor your coworkers. Check on elderly friends and family at least twice a day. Check infants and children frequently. Check on those who are overweight or in poor health.
- **Demonstrate** - Avoid hot foods and heavy meals. Make sure animals and pets have plenty of fresh water and shade. Consider bringing pets inside and wet down outside animals.
- **Don't** - Do not leave children, adults or pets in a parked car for any length of time.

daytime temperatures the following day. In 2006, a ten-day heat wave set multiple records, including maximum daily and minimum overnight temperatures. This extreme event reflected an all-time record for statewide energy consumption on July 24, 2006 utilizing 50,270 Megawatts.[12] Most importantly, there were 140 deaths attributed by county coroners to heat exposure from this event.[13] Similar in length and intensity, it is expected that more heat waves will occur on an annual basis by the end of the century if the world follows a higher GHG- emissions pathway.[14] Absent significant adaptation measures, the impacts will be severe for public health and other climate-sensitive sectors.

The increase in heat waves is expected to increase mortality in California, although the actual number of potential deaths has not been fully assessed. Over the past 15 years, heat waves have claimed more lives in the state than all other declared disaster events combined.[15] This trend is likely to continue as the number of heat waves increase, and thereby lead to potentially hundreds of climate-related fatalities every year. Even though coastal areas will not see the greatest increases in average temperature, the largest increases in mortality rates are expected to occur in coastal cities, such as Los Angeles and San Francisco since these populations are relatively unaccustomed to extreme heat and thus less acclimatized when such events occur (e.g., less adequate access to air conditioning).[16]

Beyond mortality, increased heat waves can exacerbate higher occurrences of chronic disease or heat-related illness. Compared to baseline conditions, there were 16,166 excess emergency room visits and 1,182 extra hospitalizations linked to the July 2006 heat wave throughout California.[17] As record-breaking heat waves occur more frequently in California, excess morbidity will also increase during the summer months. This will require greater preparedness by health care providers and facilities, and will place a strain on California's health care system. Heat waves also necessitate an increase in energy use for cooling and air conditioning which can lead to electricity shortages and blackouts. A reduction in energy availability can further impact public health by limiting access to air conditioning and refrigeration which can increase the risk of food-borne illnesses.

Adaptation - County of Fresno

How to Reduce the Effects of Heat

Seasonal Readiness:

- Educate the public on the greatest risks of heat;
- Identify and prepare cooling centers;
- Identify resources to transport citizens to cooling centers;
- Coordinate community resources
- Encourage residents to check on family and friends at risk.
- Initiate data collection on heat related deaths and illnesses by the Community Health Department Epidemiologist.

Heat Emergency Responses:

- Open cooling centers;
- Releasing heat response information to the media, local organizations and community groups;
- Provide transportation resources for people unable to reach cooling centers;
- Coordinate local heat-related resources, donations and volunteers;
- Monitor the health of vulnerable populations by county agencies and community groups;
- Monitor medical reports of heat-related illnesses and deaths; and
- Provide information to the public regarding available utility bill (air conditioning) assistance resources.

The expected increase in ambient temperatures is predicted to exacerbate existing air quality problems in the state if the necessary measures to reduce secondary air pollutants and their precursors are not implemented. Higher temperatures and increased ultraviolet radiation associated with global warming facilitate the chemical formation of ozone and other secondary air pollutants from precursor chemicals emitted from combustion sources such as vehicles and power plants. Air pollutants are responsible for health effects such as aggravation and development of respiratory and cardiovascular diseases.[18] Thus, these adaptation strategies should address both immediate needs and long-term impacts as warming increases the frequency and duration of extreme heat events.

Fewer Freezing Spells

Currently, freezing events occur on an annual basis in many areas of California. While freezing temperatures are important to agriculture and other sectors, freezing spells can be directly linked to public health and subsequent emergency room visits. Whenever temperatures drop below freezing, heat is lost from the body more rapidly and can bring on health emergencies in susceptible individuals, such as those without shelter, or who live in a poorly insulated home or lack a source of heat. As with extreme heat, children and the elderly are particularly at risk from hypothermia.

One of the few beneficial impacts of climate change is that freezing spells like the one experienced in December 1998 are likely to become less frequent across California as climate change progresses. Following the higher (A2) emissions pathway, freezing events could occur only once per decade in a sizable portion of the state by the second half of the 21st century.[19] As the number of freezing spells falls, Californians are likely to benefit from the decrease in these cold-related health effects. Conversely, too few freezing temperature events can lead to increased incidence of disease as vectors and pathogens do not die off.

Changes in Air Quality

Many Californians living in or near urban areas currently experience the worst air quality in the nation, with associated economic costs reaching tens of billions every year.[20] Research indicates that climate change influences on atmospheric processes will promote formation of ground-level pollutants, such as ozone and secondary aerosols (particulate matter), and that these increases could offset much of the potential gains achieved through air pollution control measures, a phenomenon referred to as the “climate penalty”.[21]

Short-term effects of air pollution include irritation to the eyes, nose and throat, as well as increased incidence of upper respiratory inflammation, headaches, nausea, and allergic reactions. In addition, short-term air pollution tends to aggravate the medical conditions of individuals with asthma and emphysema. Similar to heat waves, public health impacts from particulate matter are highest among the elderly, followed by infants and young children.[22] Recent evidence shows that increased ozone levels also impact overall mortality due to cardiovascular and lung disease; particulate matter also increases cardiovascular and respiratory illness and deaths.

A sustained increase in temperature may also play a role in human exposure to airborne allergens. Plant species are sensitive to weather and rising CO_2 levels, and warmer temperatures have been found to enhance pollen production and alter the geographic distribution of allergen-producing plant species such as trees, grasses, and especially ragweed. As a result, climate change can lead to an increase in the occurrence and severity of asthma and affect the timing and/or duration of seasonal allergies such as hay fever.[23]

B. Precipitation Changes and Extreme Events

Changes in precipitation patterns will affect public health primarily through extreme events such as floods, droughts and wildfires. In addition, higher temperatures combined with changes in precipitation patterns create conditions that are more conducive to the occurrence and spread of infectious diseases.

Floods and Droughts

The impacts of flooding can be significant. Results may include population displacement, severe psychosocial stress with resulting mental health impacts, exacerbation of pre-existing chronic conditions, and infectious disease.[24]

Additionally, impacts can include a loss of personal belongings, and the emotional ramifications from such loss, to direct injury and/or mortality. Preparation and emergency response plans are therefore needed to address anticipated flooding, especially in urban areas with high population densities which can potentially overwhelm emergency services and medical facilities.

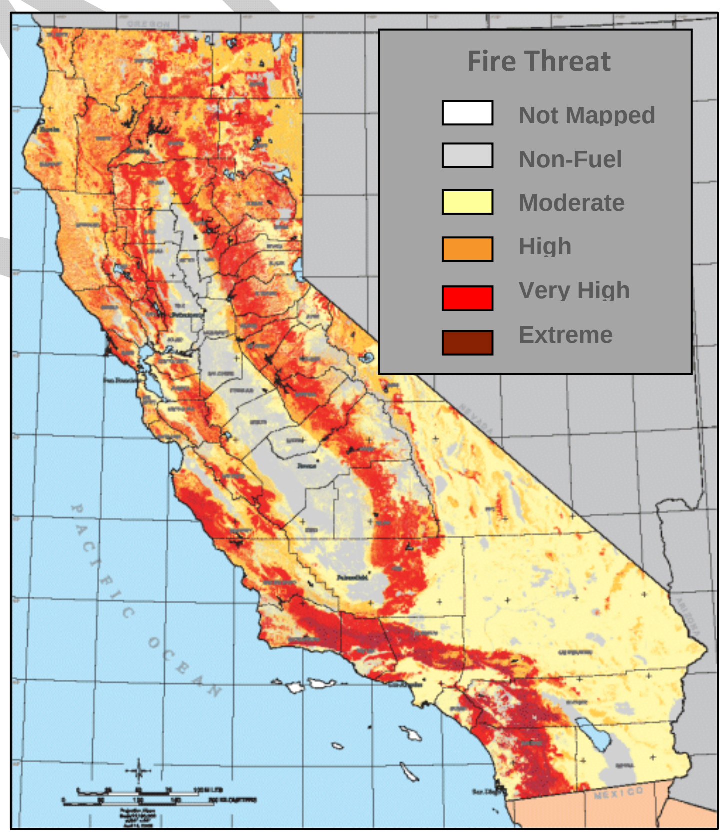
Drinking water contamination outbreaks in the U.S. are associated with extreme precipitation events.[25] Runoff from rainfall is also associated with coastal contamination that can lead to contamination of shellfish and contribute to food-borne illness.[26]

Drought impacts develop more slowly over time, allowing institutions to ramp up the needed response systems as conditions require. Risks to public health that Californians may face from drought include impacts on water supply and quality, food production, and risks of waterborne illness. Drought may lead to increases in the concentration of contaminants in drinking water supplies. Additionally, the state's agricultural sector is almost completely reliant upon irrigation and the constant supply of water from the annual precipitation received in high-mountain areas. Few, if any, studies exist which assess the impact of weather extremes on California's food security.

Wildfires

Drought also results in increased frequency and duration of wildfires; another significant risk to public health. Wildfire frequency and intensity is expected to grow as temperatures increase and vegetation dries due to longer dry seasons.[27] In addition to the associated direct risk of fatalities, wildfires can lead to immediate and long-term adverse public health problems due to exposure to smoke. Smoke from wildfires is a mixture of carbon dioxide, water vapor, carbon monoxide, hydrocarbons and other organic chemicals, nitrogen oxides, trace metals, and fine particulate matter from burning trees, plants, and built structures. During wildfires, large populations can be exposed to a complex mixture of pollutant gases and particles, which can have both acute and chronic health impacts. Smoke can irritate the eyes, harm the respiratory system, and worsen chronic heart and lung diseases, including asthma.[28] People with existing cardiopulmonary diseases are generally at the greatest risk from smoke inhalation, with age being a complicating risk factor for the exposed population.

Figure 11: *Increasing Wildfire Risk*



C. Sea-level rise

PUBLIC HEALTH IMPACTS DUE TO SEA-LEVEL RISE

- Wastewater issues with flooding of septic systems near coastline
- Salt water intrusion – risks to drinking water
- Threats of injury and even death during coastal storms
- Emotional impacts related to more coastal flooding and erosion
- Emotional impacts related to internal displacement and

As sea level rises, the flood risks public health faces will be exacerbated in coastal areas as higher storm surges cause greater tidal damage and flooding, and reach into inland areas that have been historically untouched by sea waters. Salt water intrusion into estuaries poses potential risks to water and supplies for drinking and agriculture. Potential impacts include physical injury, loss of property and belongings, and emotional trauma from such events. In one study conducted for the 2008 Climate Change Impacts Assessment, researchers assessed the areas, population, and assets at risk from inundation during a coastal storm after sea level had risen by ~5 feet (1.4 m). In the face of the encroaching ocean, up to 480,000 people and their residential assets (homes and property) are at risk (70 percent of all at-risk assets) by the end of the century from such flooding events.[29] In short, much of California's prime real estate will be affected in coming decades by accelerating sea-level rise.

Sea-level rise also increases the likelihood of saline intrusion into drinking water sources. Such events have already occurred along the Los Angeles and Orange county coastal areas since the 1950's. In response, sea water intrusion barriers were built and operated to protect these aquifers. As sea levels rise, more effort will be needed to protect these and other coastal communities from salt water intrusion into the water supply.

Infectious Diseases

Available studies and historical experience suggest that climate change could affect the range, incidence and spread of infectious diseases, including vector-borne diseases, zoonotic diseases, (i.e., animal diseases that are transmissible to humans), water-and food-borne diseases, and disease with environmental reservoirs (e.g., endemic fungal diseases).[30] In California, predictions for more frequent wildfires, droughts and heat waves are associated with possibilities for forced migration of communities which could enhance transmission of disease due to crowding, homelessness, poverty and scarce resources – here at home and abroad. Large scale migrations have been associated with surges in communicable disease and emergence of novel infections throughout recorded history. Moreover, CDPH must prepare for these new demands in an environment of funding deficits, global travel, emerging novel viruses, multiple drug resistance, current HIV/AIDS epidemic and its associated infections (e.g., tuberculosis).

Vector-Borne Diseases

In California, three main vector-borne diseases of concern that climate change may impact include human hantavirus cardiopulmonary syndrome, Lyme disease, and West Nile virus. Transmission to humans occurs through insects, ticks, and mites. These diseases vary in their response to climate-related factors such as temperature, humidity, and rainfall.[31] Climate change may impact the distribution of these vectors as humid areas become drier and less suitable habitats, while other areas may become wetter, allowing for the vectors to exist where they previously did not. Abundance of small mammal reservoirs may similarly be affected.

In California, the adult or sub-adult (nymph) western black-legged tick can transmit a Lyme disease agent to humans. The risk of acquiring Lyme disease is highly correlated with exposure to habitats where certain ticks live.[32] Lyme disease-carrying ticks are found in patchy distribution patterns in moist, humid environments such as coastal redwood or hardwood forests. The tick feeds on small mammals, lizards and, as an adult, on larger mammals such as deer. Exposure to the western black-legged tick in California is most often through recreation or occupation where ticks are prevalent. Exposure to ticks living in or near human habitations may also occur, as increased development in previously wild areas continues. Climate change may impact the distribution of the vector tick as wet, humid areas become drier and less suitable tick habitat while other areas may become wetter, allowing for the disease-carrying vector to exist where it previously did not. Abundance of small mammal reservoirs may similarly be affected.

Though increased rainfall may temporarily provide increased mosquito breeding sites, in fact, rainfall has little effect on West Nile virus (WNV) transmission since urban mosquitoes breeding in municipal water systems may benefit from below-normal rainfall. However, an increase in summer rainfall could make California more at risk for the introduction and establishment of exotic vectors such as the principle mosquito vectors of dengue and yellow fever. Each of these climate-related variables – along with unrelated changes in land use and land cover – can modify the geographic range of vectors, thereby raising the possibility that some of these vector-borne diseases may become more common in California. The first West Nile virus infection was detected in California in 2002, with explosive rates of incidence in the years since.[33]

Climate change may affect rodent populations through the availability or increase in food supplies.[34] Prolonged rainfall and/or flood can increase the food supply for rodents, thereby increasing the risk that human populations will become infected by diseases carried by rodents. Wild rodents can also act as hosts to ticks and fleas that can transmit diseases such as Lyme disease, plague, tularemia, and rickettsial infections. Humans can also contract hantavirus cardiopulmonary syndrome when they come into contact with infected rodents or their urine and droppings.

Water- and Food-Borne Diseases

The risk of water- and food-borne diseases such as mild gastrointestinal illnesses could increase as California's drinking, irrigation, and recreational waters are impacted by climate change. Such infections and illnesses can become chronic and even fatal in infants, the elderly, pregnant women, and people with weakened immune systems.

Historically, outbreaks of water-borne diseases have been linked to heavy rainfall and subsequent runoff, which results in a decline in the quality of surface water arriving at water treatment plants.[35] In California, the expected increase in the intensity of rainfall could result in periodic deterioration of the quality of drinking water, and require not only more careful monitoring, but also additional water treatment to maintain adequate water quality. People can contract water- and food-borne diseases by drinking contaminated water, eating seafood from contaminated water, and eating produce irrigated with contaminated water. They can also be exposed to water-borne infectious illnesses while fishing or swimming in affected waters. Higher water temperatures, as a result of warming, can accelerate the spread of water-borne diseases.

Harmful algae blooms, which produce nerve and liver toxins, have been noted to be of longer duration and larger intensity, and are suspected to be tied both to increased temperatures due to climate change and nutrient runoff. Exposure to marine life has resulted in death and poisonings of California sea lions. Human exposure is of concern both through drinking water contamination and recreational exposure. Human exposure to these blooms can cause eye and skin irritation, vomiting and stomach cramps, diarrhea, fever, headache, pains in muscles and joints, and weakness. Chronic exposure in drinking water supplies is suspected to have links with liver damage and cancer.[36]

D. Risks to Public Health

To summarize the changing public health risks that Californians may be facing from climate change, the likelihood of occurrence of the projected consequences was qualitatively assessed. The risk profile for public health can be characterized as follows:

Climate change is expected to lead to increases in the frequency, intensity, and duration of extreme heat events and heat waves in California, which is likely to increase the risk of mortality and morbidity due to heat-related illness and complications of existing health conditions. Those most at risk and vulnerable to climate-related illness are the elderly, individuals with chronic conditions such as heart and lung disease, diabetes, as well as mental illnesses, infants, the socially or economically disadvantaged, and those who work outdoors.

The expected increase in extremely high temperatures and increased ultraviolet radiation due to climate change is likely to exacerbate existing air quality problems unless measures are taken to reduce GHG as well as air pollutants and their precursors. Climate change can lead to an increase in the occurrence and severity of respiratory illnesses as a result of declining air quality combined with higher temperatures. It can also alter the timing and/or duration of seasonal allergies.

Changes in precipitation patterns affect public health primarily through potential for altered water supplies, and extreme events such as floods, droughts, and wildfires. These extreme events are likely to increase, thereby exposing the population to the risk of direct injury and/or mortality, loss of property and belongings and the emotional trauma associated with them. Adequate preparation is needed to provide sufficient emergency services and access to medical facilities. The direct risk of injury and fatalities from a combination of wildfires, higher temperatures, and longer dry seasons will contribute to an increase in poor air quality and related respiratory illnesses.

Wide ranging and unpredictable communicable disease impacts that are likely to result from climate change highlight the need to strengthen public health infrastructure related to electronic disease surveillance, food and water safety, control of insect vectors, control of animal reservoirs of diseases, and increasing the capacity of infectious disease outbreak response.[37]

Public Health Adaptation Strategies

Introduction

The state agencies that participated in the Public Health Climate Adaptation Working Group (led by the California Department of Public Health, with assistance from the Air Resources Board) developed the following strategies and shall be responsible for and will spearhead strategy implementation. Public Health adaptation strategies are driven by the desire to minimize the negative health impacts of climate change. The strategies are designed to increase awareness about potential climate change-related public health impacts; improve overall public health and resilience to prepare for future changes; protect those who are vulnerable; and support research and resources that allow for ongoing strategy improvements.

These adaptation strategies provide guidance on steps that California's public agencies can take to prevent and prepare for the impacts of extreme events. For example, recommended measures include improvements in health preparedness and emergency response, proper surveillance of climate-related illness, and the means to promote community resilience while reducing vulnerability. Several strategies may help prevent impacts from both extreme events and gradual changes. Urban forests, for example, have the potential to reduce heat island effects; especially when used in combination with cool roofs or other building standard modifications.

Steps to reducing community vulnerability to climate change include enhancing public health infrastructure, promoting sustainable local food systems, and promoting strong social support networks. Improving public health preparedness and emergency response will be addressed by improving public education, coordination among emergency personnel, and development of enhanced heat warning systems. The means to improve surveillance of climate-related illness include identification and tracking of health conditions that increase vulnerability to climate-related illness and deaths (e.g., chronic diseases), real-time electronic tracking of climate-related illness and death, conducting post-disaster surveillance, and tracking of environmental conditions that provide early warning systems of climate-related health risks.

Public health and the resulting effects of climate change on human populations in California are of significant concern. Due to the complex links between climate variables and public health, and the corresponding challenges associated with ongoing research, substantial efforts and resources are needed to clearly understand how this sector can best adapt to a changing climate.

Furthermore, the impacts of adaptation strategies intended to protect public health may have detrimental effects on natural ecosystems. For example, control and abatement actions on pests and disease-carrying organisms could result in contamination of natural environments; many of which provide resources such as clean and safe drinking water for human populations.

Adaptation Strategies and Actions

The Public Health Climate Change Adaptation Work Group, in concert with the Department of Public Health, has identified the following priorities in addressing climate adaptation for California state agencies. The near-term actions referenced below are those actions that have been identified which can be initiated by 2010 (contingent on sustained funding). The long-term actions include those recommended actions that will require support from the state and collaboration with multiple state agencies and are identified as cross-sectors strategies.

Strategy 1: Promote Community Resilience to Reduce Vulnerability to Climate Change. Communities which have lower baseline rates of disease and are changing their infrastructures to combat obesity and chronic disease will be more resilient to climate change threats to health.

<u>Near-Term Actions:</u>

a. **Integrate Climate Resiliency** – CDPH should continue to conduct public health programs that work to support climate resilient communities (e.g., walkable communities, Safe Routes to Schools, Public Health and the Built Environment, the Landscaping and Health Workgroup, Storm Water Drainage System, and “Fight the Bite” campaign for personal protection from mosquitoes, etc).

b. **Putting Health Considerations in Land Use and Transportation** – CDPH should form a working group to improve community planning and design to promote healthy living and balance and integration of social, economic and environmental concerns. This can be done, for example, by promoting access to healthy foods and ability to walk or bicycle on a daily basis into land use plans and by including health considerations, both co-benefits and negative consequences of land use, into transportation and housing planning and decisions.

c. **Food Security and Quality** – CDPH should build partnerships with the Prevention Institute and other NGOs who are interested in improving access to healthy foods in low-income communities. CDPH should maintain its commitment to its healthy foods programs (e.g., WIC (Women, Infants, and Children Nutrition Program), Supplemental Nutrition Assistance Program Education, programs that promote farm-to-consumer).

Long -Term Actions:

d. **Health Access** – CDPH should promote increased access to health care, in order to ensure that at risk populations are prepared for gradual and extreme climate change events. CDPH should especially support policies which focus on health care access in communities with current high burden of disease.

e. **Food Transport/Mitigation** – CDPH should promote sustainable local food systems to reduce reliance on food that requires a high amount of "vehicle miles traveled". This could be done through supporting projects with mutual partners and/or through media/outreach campaigns.

f. **Reduce Heat Islands** – CDPH should partner with academia, state and federal agencies, and other climate change experts to identify urban heat islands, and work with state and federal agencies such as CAL FIRE, USFS Urban Forestry Program and DPR (Department of Parks and Recreation), and community partners to increase ground cover and shading by expanding urban forests, community gardens, parks, and native vegetation-covered, as well as open spaces.

Strategy 2: Educate, Empower and Engage California Citizens, Organizations and Businesses to Take Actions to Reduce Individual and Community Vulnerability to Climate Changes through Mitigation and Adaptation.

Near -Term Actions:

a. **Educational Outreach Campaign** – Initiate the development of diverse education materials based upon social marketing concepts for diverse populations (general population, vulnerable communities, school-age children, business, and labor) that focus on the impacts of climate change and subsequent actions can be taken to mitigate and adapt to climate change. Utilize existing resources such as the bepreparedcalifornia.ca.gov website to post information.

b. **Reduce Exposure to Risk** – Educate communities on the reduction of exposure to climate impacts, air quality and other toxic exposures (e.g., Mold Hotline, blue-green algae and human exposures in recreational environments).

c. **Mitigation and Adaptation Education** – Disseminate information specific to vulnerable populations (e.g., outdoor workers and their employers, residents in urban heat islands, asthmatics, immigrants with literacy/language needs).

d. **Occupational Safety Standards** – Advise and revise occupational health and safety standards to identify occupations at risk due to climate change.

Long-Term Actions:

e. **Institutional Capacity** – CDPH should expand training and education of health and social services providers, identify and integrate mental health services into post-disaster recovery or other dislocating or disruptive climate related changes.

Strategy 3: Identify and Promote Mitigation and Adaptation Strategies with Public Health Co-benefits.

<u>Near -Term Actions:</u>

a. **Mitigation and Adaptation Benefits** – CDPH should identify public health strategies that offer concomitant climate change mitigation and adaptation benefits (e.g., Promote "smart growth" that reduces the need for automobile use while promoting physical activity and enhancing access to essential services).

b. **Health Impact Assessments** – CDPH should develop guidelines for health impact assessment, for use by local health departments and other agencies. CDPH should conduct health impact assessments of proposed mitigation and adaptation strategies, which include impacts on vulnerable populations and communities and assessment of cumulative health impacts. Conduct health impact assessments of land use, housing and transportation proposals that could impact health, GHG emissions, and community resilience for climate change and strive to ensure that these proposals and planning includes participation and collaboration by public health professionals in addressing mitigation and adaptation (e.g., SB 375 – Sustainable Communities).

Strategy 4: Establish, Improve and Maintain Mechanisms for Robust Rapid Surveillance of Environmental Conditions, Climate-related Illness, Vulnerabilities, Protective factors and Adaptive Capacities.

<u>Near -Term Actions:</u>

a. **Monitor Outcomes** – CDPH should increase its capacity to monitor the climate related deaths and illnesses associated with heat-related and other events, including recommended indicators by the Council of State and Territorial Epidemiologists, and help to develop capacity for local health departments.

b. **Environmental Contaminant Biomonitoring** – CDPH and Cal/EPA (California Environmental Protection Agency) should encourage the development of the existing California Environmental Contaminant Biomonitoring Program to determine the level of contaminants in California residents to help reduce baseline illness and increase community resiliency.

c. **Vulnerability Assessments** – CDPH should conduct detailed vulnerability assessments for all the leading climate-change health outcomes (e.g., heat morbidity, valley fever, flooding, wild fires) utilizing locally scaled-down emergency and environmental shift scenarios. Ecological shifts and other environmental changes associated with climate change have longer-term implications for health (e.g., increased occurrence of communicable diseases, reduced water supplies and degradation of drinking water quality, and contributions to chronic disease development and progression).

d. **Electronic Surveillance Systems** – The CDPH should continue actions to improve disease reporting, management and surveillance by replacing the current paper based system with a secure electronic system (California Reportable Disease Information Exchange - Cal-REDIE or WebCMR (Web Portal for the Confidential Morbidity Report)). Actions should be taken to consider mandatory reporting of climate-sensitive morbidity and mortality.

e. **Health Information Systems** – The CDPH should maintain and upgrade the existing Rapid Response Registry (which provides health information services and tracks participant contact information) for individuals exposed or potentially exposed to an emergency event. Additionally, maintain operating the California Environmental Tracking Program which conducts surveillance of environmentally-related chronic disease. The CDPH should consider creating a clearinghouse of climate-related health outcome data for access and distribution to local health departments and community organizations.

f. **Water Accessibility Information** – Maintain and upgrade the existing Safe Drinking Water Information System, which provides information about public water systems and their violations of EPA's drinking water regulations regarding maximum contaminant levels, treatment techniques, and monitoring and reporting requirements, in order to ensure safe and reliable public water resources.

g. **Infectious Disease Monitoring** – Continue to monitor the frequency of occurrence of environmental infectious diseases, including Valley fever and vector-borne diseases, such as West Nile virus, Lyme disease, and hantavirus cardiopulmonary syndrome.

h. **Electronic Surveillance Systems** – Expand the Electronic Death Reporting System for the continuous monitoring of abnormal death patterns, pneumonia, asthma, and heat deaths. Also, expand the usage and coverage of Cal-REDIE to allow seamless sharing of information across California to identify and manage multi-jurisdictional outbreaks effectively. This will ensure a comprehensive central data repository.

<u>Long -Term Actions:</u>

i. **Emergency (Event) Monitoring** – Build a real-time data collection system for the daily monitoring of emergencies based on daily hospitalizations data, emergency department care, and diagnostic, laboratory, and prescription information.

j. **Health Information Exchange** – Identify strategies and resources to integrate all California Emergency Rooms into electronic health records systems, and ensure local and state public health access to that data for purposes of surveillance and emergency response. Integrate Cal-REDIE with all appropriate Health Information Exchange applications.

Strategy 5: Improve Public Health Preparedness and Emergency Response

<u>Near -Term Actions:</u>

a. **Public Health Advisories** – Maintain distribution of public health advisories in response to climate change impacts (e.g., prevent heat illness, vector-borne or food borne disease) while targeting vulnerable populations (e.g., outdoor workers and their employers, residents in urban heat islands, asthmatics, immigrants with literacy/language needs).

b. **Preparedness Response** – CDPH should refine existing emergency preparedness plans for common current scenarios (e.g., heat waves, wildfires, floods) and maintain and build capacity to respond to future climate change impacts (e.g., sea-level rise, flooding, heat-waves etc.) by enhancing emergency preparedness and response activities in collaboration with local agencies.

Strategy 6: Work in Partnership with Multiple Agencies (e.g., Environmental, Agricultural, Transportation, and Education at Local, State and Federal levels, as well as Business, Labor, Schools and Community-based Organizations.

<u>Near -Term Actions:</u>

a. **Collaboration/Stakeholders** – CDPH should maintain leadership in the Public Health Working Group for the iterative development of the Climate Adaptation Strategy. CDPH should encourage ongoing participation with Public Health stakeholders (local government, health care providers, mental health and social service providers, non-governmental organizations and the private sector, as well as state, federal agencies) to develop local adaptation strategies that serve to mitigate and adapt to future climate change impacts.

b. **Encourage Participation** – CDPH should establish and maintain linkages between climate change and the public health community while demonstrating and encouraging further development of public health strategies at federal, state, and local level meetings to educate and inform participants and stakeholders.

Strategy 7: Conduct Research to Enable Enhanced Promotion and Protection of Human Health in Light of Climate Change.

<u>Near -Term Actions:</u>

a. **Research Vulnerable Populations** – Initiate efforts that will aid in determining the impacts of mitigation and adaptation strategies on vulnerable populations.

b. **Collaboration/Research** – Develop a closer working relationship with the University of California and other universities and NGO's involved with climate change analysis and impacts.

c. **Collaboration/Government** – Provide input to agencies conducting climate change research and releasing public health impact reports on climate change such as the U.S. Center of Disease Control and Prevention, the World Health Organization, the U.S. Environmental Protection Agency, and the U.S. Climate Science Research Program.

<u>Long -Term Actions:</u>

d. **Local Research & Analysis** – Engage in research to determine local climate change impacts.

Strategy 8: Implement Policy Changes at Local, Regional and National Levels.

<u>Near -Term Actions:</u>

a. ***Policy Integration*** – Work with local and state agencies to ensure that public health is considered in all policy development and work with stakeholders to develop federal and state policies to implement adaptation strategies.

b. **Policy Tracking** – Monitor global, national and other state policy trends to emulate in California.

<u>Long -Term Actions:</u>

c. **Model Policies & Training** – Identify model adaptation policies for local communities, and provide supportive training and technical assistance to facilitate implementation.

d. **Public Engagement** – Initiate the engagement of all sectors of government, thereby including public health issues in all climate change policies they that offer possible co-benefits for climate change adaptation.

Strategy 9: Identify, Develop and Maintain Adequate Funding for Implementation of Public Health Climate Adaptation Strategy.

<u>Near -Term Actions:</u>

a. **Funding Mechanisms** – Develop a comprehensive funding strategy for public health adaptation strategies that utilize a broad range of funding strategies including fees, taxes and grants.

b. **Existing Funding** – Identify existing resources that can be utilized for public health adaptation activities.

c. **Collaboration/Federal Agencies** – Formally request the U.S. Department of Homeland Security and the Centers for Disease Control and Prevention to incorporate climate change response and preparedness as an acceptable use of federal funds for public health preparedness.

<u>Long -Term Actions:</u>

d. **Funding Mechanisms/AB32** – Develop proportional funding proposal for public health research, adaptation and climate resiliency education that addresses Environmental Justice, and is based upon market mechanisms such as carbon auctions and carbon trading.

Strategy 10: Lead by Example - Encourage Active Participation of Public Health and Health Organizations in Individual, Organizational, and Institutional Efforts to Mitigate and Adapt to Climate Change.

<u>Near -Term Actions:</u>

a. **Foster Mitigation through Public Health Action** – Initiate mitigation and adaptation considerations in all public health policies and programs, thereby reducing negative impacts of program operations and create co-benefits (e.g., videoconferencing versus carbon producing travel).

V. BIODIVERSITY AND HABITAT

Introduction

California is one of the most biologically diverse regions of the world and its vast array of species and habitats make it one of the 25 biodiversity "hotspots" on earth.[1] Hot spots are areas where at least 1,500 species of vascular plants (> 0.5 percent of the world's total) are endemics and where at least 70 percent of the original habitat has been lost. Of all 50 states, California has the most unique plant and animal species, as well as the greatest number of endangered species.[2] The state's diverse biodiversity stems from its varied climate and assorted landscapes which have resulted in numerous habitats where species have evolved and adapted over time. The state's ecological communities include coastal mountain ranges, coastal dunes, wetlands, rivers, lakes, streams, deserts, grasslands, and inland forested mountains. The vast number of species found in much of California makes it a "hotspot" for biodiversity (Figure 12).[3]

Figure 12: *California's variety of species and habitats makes it a biodiversity hotspot*

California is one of only five regions in the world with a Mediterranean climate. Habitats in these climatic regions are considered to be more threatened by climate change than tropical forests, since over 40 percent of these lands worldwide have been converted to other uses and less than five percent are protected worldwide.[4] According to some estimates, more than 20 percent of the naturally occurring species of amphibians, reptiles, birds, and mammals in California are classified as either endangered, threatened, or "of special concern" to state and federal agencies.[5] Therefore, the preservation of California's unique biological heritage is of ever-increasing importance given the forecasted impacts associated with climate change.

The economy and the natural resources that sustain human life are dependent upon the state's biodiversity. These species and ecosystems provide numerous goods and services, including provisioning services (e.g., food and timber production, medicines, water and fuels), regulating services (e.g., water purification and carbon sequestration), supporting services (e.g., climate regulation and nutrient cycling) and cultural services (e.g., aesthetic values, and sense of place).[6] Not only do these goods and services support California's economy but they support numerous recreational activities for residents.

Future Climate Change Impacts to Biodiversity and Habitat

A. Increased Temperature

Every species has a temperature range in which it thrives and can survive. Brief exposures to extreme temperature events or repeated occurrences of temperatures outside of the range will stress plants and animals, and will exacerbate environmental pressures exerted by competitors, predators, pests and invasive species, habitat change, varying food and water supplies, diseases, and other anthropogenic stressors such as contaminants and habitat fragmentation. As average temperatures rise, plant and animal species will increasingly be confronted by thermal stress that is out of their ability to adapt. This will force terrestrial plants and animal species to either adapt to these changing conditions, shift to new habitats to avoid them if possible, or be extirpated (Figure 5.2).

Species that cannot adapt in their existing communities may, over time, shift in their ranges if appropriate habitat is available, accessible, and if their behavioral characteristics allow. If they are unable to shift their ranges, they face the threat of local extirpation, if not extinction. The amount of future warming expected in California may likely exceed the tolerance of endemic species (i.e., those that are native to a specific location and that occur only there) given their limited distribution and microclimate.

Biodiversity and Habitat Impacts due to Warming

- Barriers to Species Migration and Movement
- Temperature Rise - Lakes, Streams, and Oceans
- Increase in Invasive Species Potential
- Changes in Natural Community Structure
- Threats to Rare, Threatened, or Endangered Species
- Altered Timing of Phenological Events
- Timing Disruptions Between Predators and Prey and Pollinators and Plants
- Loss of Ecosystem Goods and Services

Species that have the capacity to shift their ranges will require movement corridors that are not blocked by natural landscape features or human development. Planning to maintain natural corridors in anticipation of predicted climate changes should be factored into future local and regional habitat conservation planning efforts.

If the past is any indication of the future, we can assume that species occurring together in communities will move independently from each other, not as groups. As a result, species will likely reorganize into communities made up of different species. For example, cores of fossil pollen from dozens of sites around North America show that in the last Ice Age, boreal tree pollen, which today occurs in the boreal zone in Northern Canada, was common in the Corn Belt of the United States and in areas where mixed hardwood forests exist today. Pollen cores show us that different tree species that were living together then are no longer found together.[7]

Similar stresses and barriers apply to aquatic species whose migratory/movement limitations may be even more limited. Vernal pool and freshwater lake species are likely to be more susceptible to extirpation because their habitats may disappear entirely or if they are unable to emigrate to a new aquatic environment. For example, fish and amphibian species will experience increased stream and lake temperatures that will affect their food supply and fitness. Warmer air and water conditions could also influence the introduction and spread of undesirable species or diseases.

Invasive Species

As climate change related impacts increase, the ranges occupied by certain species will change. Species attributes that facilitate this change include broad environmental tolerances, animals that don't have specialized diets, a relatively rapid rate of reproduction and the ability to disperse to new locations. Under future climate conditions grassland habitats and deserts are expected to expand, resulting in species in those habitats having suitable habitat in larger regions, while in comparison slower-growing vegetation communities with limited dispersal capabilities may be outpaced by climatic change. As a result, even species that are native to certain California regions may disrupt ecosystem balance as they spread into other regions. Disturbance events generally benefit invasive species given their tolerance to a wide range of environmental conditions. Invasive species often have greater flexibility and can survive under variable and extreme conditions, such as flood events or drought. Invasive species also tend to produce large numbers of seeds or young and are capable of long distance dispersal; or have the ability to outcompete native species (especially plants that requires no pollination or seed development).

Californians have benefited from the introduction of plant and animal species necessary for food or other human pursuits; however, there are many other introduced species that can wreak havoc on the state's environment and economy. Invasive species threaten the diversity or abundance of native species through competition for resources, predation, parasitism, interbreeding with native populations, transmitting diseases, or causing physical or chemical changes to the invaded habitat. Through their impacts on natural ecosystems, agricultural and other developed lands, water delivery and flood protection systems, invasive species may also negatively affect human health and/or the economy. Examples of direct impact to human activities include the clogging of navigable waterways and water delivery systems, weakening flood control structures, damaging crops, introducing diseases to animals that are raised or harvested commercially, and diminishing sport fish populations.

Ecosystem Services: Community Composition and Interactions

The impact of warming has already affected the timing of biological events such as flowering, leafing out, breeding, and migration and will continue to do so. This change in composition can disrupt biological interactions and impact ecosystem dynamics by displacing existing biological interactions and replacing it with another. For example, an earlier occurrence of flowering may result in futile reproduction efforts for pollinators if they are unable to adjust quickly to the change in availability of resources. Changes in pollinator activity will affect dependent species throughout the natural and human food chain.

Carbon sequestration which helps to regulate the Earth's climate is an ecosystem service that greatly benefits humans. Indeed, California's ecosystems, including forests, open spaces, and wetlands provide co-benefits such as carbon sequestration and managing them effectively will be among California's most important tools in the fight to reduce GHG emissions. In addition, these habitats are also home to thousands of native plant and animal species. Historically, these landscape types and others have used natural processes to regulate the majority of atmospheric carbon. When properly managed, public and private forests, open spaces, and wetlands may have the potential to provide significant capture and sequestration of greenhouse gases while simultaneously providing habitats necessary for the long-term conservation of California's biodiversity.

B. Precipitation Changes and Extreme Events

Changes in Stream Flow

Current projections for California suggest that precipitation and temperature events will be more extreme. For example, more frequent and intense heat waves can impact heat-sensitive species, reducing fitness and increasing mortality. With more precipitation falling as rain (less snow pack), river flows during the winter and spring seasons will be greater; while reduced snowfall in the winter will result in reduced snowmelt and subsequently lower stream flows during summer months.

One of the first species groups impacted by stream flow change will be fish. Fish reproduction is affected by stream flows in several ways. Increases in winter runoff and earlier spring peak flows are likely to lead to increases in the number of flooding events during these seasons. Early-spring, high-runoff periods or flooding may occur during egg incubation periods for many fish species, thus impacting reproduction. High stream flow could additionally shift streambed gravel, and heighten the risk of damage to incubating eggs; while the emergence of juveniles can be displaced, undermining the reproductive success of species.[8]

Mosquitoes will proliferate in areas where flooding combines with higher springtime temperatures. If these areas are chemically treated to protect human health, non-target invertebrates that feed fish and other aquatic species will be affected. Introduced toxins will have unintended consequences for the entire food chain. (See also Public Health chapter for additional information on climate change impacts to public health.)

As a result of a decrease in snow pack and earlier snowmelt, stream flows are expected to be lower during the summer months and extending into the fall. In addition, reduced stream water depth and higher air temperatures will increase stream water temperatures, to levels that are potentially unhealthy for coldwater fish. Salmonids are temperature-sensitive and rely on precipitation and snow melt. The projected changes in inland water temperatures with changing seasonal flows is projected to place additional stress on these species (Figure 5.3), contributing to the need for increased resources for monitoring and restoration efforts. It is common for adult fish migrating to spawning grounds to encounter obstacles that require high flow conditions in order to pass. If climate change results in reduced stream flows this could impede or halt their progress. A delay in the arrival to spawning grounds may decrease reproductive success and increase fish mortality. Repeated low stream flows during spawning migration periods may naturally select against large adult body sizes.[9]

The projected changes in temperature and precipitation patterns will also affect the distribution and longevity of available surface water. Changes in the composition and structure of riparian communities may result from changes in precipitation and flow and could contribute to increased management conflicts as the needs of humans and wildlife compete for limited resources. Changes in temperature and precipitation associated with climate change may lead to less stored water and will have a direct effect on the survival of aquatic species and the preservation of wetland habitats.[10]

Other factors impacting aquatic species may be exacerbated by changes in precipitation including the timing and amount of river and stream diversions, temperature changes and pollution or sediment load.

Biodiversity and Habitat Impacts due to Precipitation Changes

- Stream Flows - Impact to Fish Passage
- Distribution/Longevity of Surface Water, Impact to Wildlife
- Changes in Riparian Communities and Structure
- Decreased Water Availability - Fish and Wildlife
- Water Temperature, Pollution and Sediment Load Changes
- Impacts to Water Dependent Species
- Surface Water Allocations - Impact All Water Users (humans & wildlife)
- Increased Susceptibility to Pests, Disease, Wildfires & Invasive Species
- Habitat Conversions - Changes in Biodiversity

Floods and Droughts

Aside from the impacts of high-runoff events and flooding on stream habitats and fish populations, periodic floods have always been a part of the formation of landscapes and ecosystem processes. Species and ecosystems in riparian habitats are largely adapted to such events. Many California land use decisions, however, have created conditions that have separated streams and rivers from their historical floodplains through either construction of levees, development on floodplains, or both. These activities reduce the adaptive capacity of remnant riparian ecosystems, especially if flooding is projected to increase in late winter and spring as a result of climate change. When riparian habitats are adjacent to urbanized areas, increased flooding can burden these pristine ecosystems with heavier and sometimes more toxic sediment deposits. In the highly developed coastal floodplains, where storm-related coastal flooding may coincide with high tides and stream runoff, ecosystems will face great challenges. Likewise, the projected increase in drought conditions will further impact stream and terrestrial habitat quality as well as the adaptive capacity of ecosystems to continue to provide their goods and services.

Prolonged periods of drought can make ecosystems vulnerable to pests, non-native species invasions and frequent and intense wildfires. Moreover, reduced rainfall and snowmelt will lead to less water infiltrating the soil, stressing plants and animals. This reduced infiltration rate will also diminish groundwater recharge. Lowered levels of groundwater, combined in coastal areas with saltwater intrusion, will exacerbate dry conditions and further stress species and habitats. Together, all these changes in water availability can cause landscape transformations as conditions select for species that require less water. (See the Water chapter for more discussion on climate change impacts on freshwater ecosystems and species.)

Wildfires

Fire plays an important role in the condition, function, and distribution of many of California's natural habitats and has done prior to and since human settlement. Aspects of fire regime, frequency, intensity, severity, magnitude, and pattern, have fluctuated over time. Since the 1980s, the state seems to be experiencing changes in the frequency, intensity, and duration of wildfires. Land-use and land management policies, particularly in conifer forest and chaparral communities, are thought to have affected attributes of fire regimes throughout human history. In recent years, researchers have determined that changes in climate have had an important role in altering fire regimes. Current information suggested an extension of the fire season and increasing the number of large wildfires, as well as wildfire intensity. Particularly, higher spring and summer temperatures and earlier spring snowmelt are thought to have contributed to these changes.[11]

In one climate change scenario, potential fire fuels can build up during wet years when plant production is high. Preconditions for catastrophic wildfires will occur if ensuing weather conditions include decreased precipitation or drought that dries out the accumulated fuel. Large scale and intense wildfires could result in vegetation and habitat alterations, resulting in displacement of local species for variable amounts of time, sometimes years. Fire in conjunction with other stressors such as fragmentation, urban developments, etc could promote the establishment of invasive species, which may contribute to displacement of native species, ecosystem services, and commercial products. The recruitment of invasive grass species in fire-disturbed areas can increase fine fuel loads, resulting in greater fuel continuity, frequency, and rate of spread.[12]

Due to changes in temperature and precipitation associated with climate change, researchers expect the frequency of wildfires to increase over and beyond the recently experienced trends. Depending on which emissions and population growth scenario is used, and what land use and vegetation assumptions are made, projections vary and uncertainty increases with time. The number of wildfires associated with the higher emissions pathway (A2) is substantial, with statewide increases ranging from 37 to 94 percent by 2085.[13]

Most California plant systems depend on fire. Exclusion of fire or altering its regional fire regime attributes will alter the systems and both eliminate animal species and change, if not decrease, existing biodiversity. Some of the wildlife benefits of wildfire include the (1) recycling of dead and downed vegetation and creation of new deadwood and snags,[ii] (2) cycling of soil nutrients, (3) removal of excess, woody vegetation which provides for herbaceous plants and younger plants to grow and new and palatable vegetation for herbivores, (4) opening up of the under story for browsing for larger wildlife species, and (5) creation of tree holes utilized by cavity-nesting birds, bats, and arboreal mammals. These benefits are typically derived from low- to moderate intensity fires, and in some cases, depending on the vegetation community, infrequent, high-intensity fires. However, benefits are not derived from the more frequent, high intensity wildfires that California has experienced in recent years, especially in conifer systems in the western Sierra Nevada and chaparral systems in southern California.

Destructive impacts from wildfires can be reduced through prescribed burning in forests and shrublands in some areas of California. State and federal land management agencies regularly conduct prescribed burns for ecological purposes and to reduce fuel loads in critical areas. However, these efforts do not come close to meeting the need for fire on areas identified for prescribed burning. For example, state parks burn under controlled conditions about five percent of what they deem necessary. Prescribed burning in many forested areas, including old growth, is not possible until heavy understory fuel accumulations have been reduced requiring intensive effort before burning takes place. Regulatory requirements, e.g., air quality and listed species protection, can also impact or reduce prescribed burning activities. In appropriate locations the ability to increase prescribed fire activities will contribute to healthy, more natural forest conditions and reduce the risks of catastrophic wildfire. On the other hand, many shrubland areas, especially in Southern California, burn more frequently than the natural fire cycle dictates. Understanding the complete fire history in different vegetation areas is important before prescribed burning occurs.

Fire prevention and natural resource managers across the state must work together to support key fuels management measures to find a balance between protecting the public, existing infrastructure, and the essential ecological role that fires play in ecosystems. (See the Forestry chapter for additional information on climate change impacts on forests and wildfire.)

C. Sea-level rise

California's coastal areas include a variety of habitats that range in their characteristics from purely aquatic, to semi-aquatic, to terrestrial. All habitats are influenced by periodic flooding by tidal waters, rainfall, or runoff. These wetlands, dunes, and rocky habitats are home to a vast number of organisms, including many endangered species. During certain periods, wetlands harbor juveniles of numerous aquatic species including fish and shellfish. Wetland habitats from the Sacramento Valley southward to the Salton Sea and the tidal marshes of San Francisco Bay also provide essential wintering habitat for hundreds of thousands of birds as they migrate north and south along the Pacific Flyway. Humans additionally benefit from the ability of healthy wetlands to buffer storm impacts, reduce shoreline erosion, improve water quality, and provide beautiful areas for recreation.[14]

Located between sea and land, coastal habitats have adapted to dynamic changes over time. Accelerating sea-level rise may overwhelm their natural capacity to adapt due to concurrent stresses and pressures from human development and coastal land use decisions. Existing stresses include ongoing discharge of organic wastes fostering eutrophication, legacy of organic pollutants and other toxic substances, pathogen loading, sediment and freshwater delivery alteration, thermal pollution, direct wetland infill and destruction with subsequent habitat loss, bottom disturbance from fishing practices and recreational boating, extraction of living and non-living material and influx of invasive species.[15] Thus,

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[ii] One of the most crucial habitat elements for woodland and forest invertebrates, vertebrates, and fungi.

the biodiversity and habitats of coastal areas may be particularly impacted by sea-level rise and other climatic changes.

Some coastal habitats, such as wetlands and dune habitats can become permanently inundated and eroded if sea level rises faster than these ecosystems can move inland. Moreover, inland migration is frequently hindered by development such as bulkheads, seawalls, roads, and buildings. Continued growth and development in coastal areas will only increase the direct pressure on remaining habitats and make inland migration more difficult. Sea-level rise, especially at the increasing rates projected for the 21st century, may result in the loss of substantial areas of critical habitat for a variety of coastal species.[16]

The degradation of sensitive ecosystems can be brought about not just by higher sea levels but also by other climate changes, including higher temperatures and changes in precipitation patterns, which together can facilitate the establishment of invasive species such as European beach grass. Both aquatic and terrestrial coastal ecosystems may thus see further increases in problems with invasive species.[17]

Sea-level rise will also result in salt water intrusion into fresh water resources near the coast, reducing the amount of fresh water available for plants, wildlife, and competing agricultural and metropolitan uses. Species with greater salt tolerances may have a selection advantage where habitats can naturally transform, without human interference. Sea-level rise, in conjunction with coastal storms, may also lead to coastal flooding that extends further inland, thus increasing the risk of pollution, runoff, and sedimentation in fresh water sources of previously unaffected areas. This degradation of fresh water in near-coastal areas may aggravate conflicts over water for human uses versus ecosystem and species needs.

There will also be shifts in the type and location of agriculture as saltwater intrudes into coastal aquifers and natural recharge of groundwater resources decreases with the drying climate. Water transfer and management impacts may become increasingly complex, as there may be impacts to hydropower and hatchery project operations as well as water diversion projects.

Changes to the timing and intensity of freshwater input may impact marine and near shore populations through increased runoff resulting in pollution and sedimentation contamination and shifts in urban growth and development will place new or increased pressure on existing coastal resources and available habitat. Inundation of coastal infrastructure could cause widespread pollution and contamination further jeopardizing marine and near-marine environments. Changes in ocean circulation and ocean warming will impact pelagic species distribution and community structure. In addition, ocean acidification could impact shellfish species as well as their prey base. Protected areas such as ecological reserves, wildlife areas, undesignated lands, mitigation sites and easements could also be affected, and require management decisions that protect California's natural resources. These challenges and many more will require close coordination with those entities implementing the oceans and coastal adaptation strategies. Please refer to the Oceans and Coastal Resources chapter for additional information.

Monitoring and Adaptive Management

Natural communities, ecosystems, species population dynamics, and the effects of stressors on the environment are inherently complex. Wildlife and resource managers often are called upon to implement conservation strategies or actions based upon limited scientific information and despite considerable uncertainties. Adaptive management is a key element of implementing effective conservation programs especially in light of some of the uncertainties associated with climate change. Adaptive management combines data from monitoring species and natural systems with new information from management and targeted studies to continually assess the effectiveness of, and adjust and improve, conservation actions.

California's Wildlife Action Plan summarizes current monitoring programs and addresses the steps and considerations needed to design a monitoring program in an adaptive management context.[18] It also provides a process for establishing monitoring programs and will be an important resource and framework for the implementation of some of the specific climate change adaptation strategies detailed in this document.

D. Risks for Biodiversity and Habitats

In summary, some of the current and future climate change impacts to biodiversity expected in California include:

- Temperature-sensitive terrestrial plant and animal species must adapt to warmer temperatures either within their existing ranges or move to new habitats at higher altitudes or latitudes if possible.
- The amount of additional warming expected in California in the future may exceed the tolerance of some species, particularly endemic ones. Where relocation access is blocked off by natural landscape features or human development, species will need corridors to establish habitat connectivity or face a growing risk of extinction (Figure 5.6).
- Similar stresses and barriers apply to aquatic species, but their migratory limitations may be greater.
- The problem of invasive species is likely to become even more challenging in the future, as invasive species are typically more competitive than native species especially in damaged/degraded environments.
- Species migration/movement and invasions along with changes in behavior of temperature-sensitive species will cause imbalances and disruptions to current ecosystem dynamics.
- Changes in precipitation patterns will alter stream flow and severely affect fish populations during their life cycle. Low-flow conditions and higher stream flow temperatures are particularly threatening to coldwater fish.
- Human activities across the state have reduced the ecological integrity of many areas as well as the levels of biodiversity. Climate change will act synergistically with existing stressors to have an even greater impact on already stressed ecosystems.

BIODIVERSITY & HABITAT IMPACTS DUE TO SEA-LEVEL RISE

- Inundation of Permanent Coastal Habitat
    - Alteration of Dune Habitat & Coastal Wetlands
    - Coastal Habitat Loss of Migratory Birds, Shellfish & Endangered Plants
- Reduction of Fresh Water Resources Due to Salt Water Intrusion
- Sedimentation Increases May Increase Pollution and Run Off
- Degradation of Aquatic Ecosystem
- Increase in Invasive Species
- Competition for Coastal Land Areas
    - Shifts in Urban Growth and Development
    - Agricultural Relocation
    - Alterations of Ecological Reserves, Wildlife Areas, Undesignated Lands, Mitigations Sites & Easements
- Groundwater Recharge & Overdrafting
- Water Management & Water Transfer Conflicts
- Reduction in Wetland Habitat on Commercial and Sport Fisheries

- Longer fire season trends over the last three decades and increased numbers of large, intense wildfires are projected to continue, increasing the risk of vegetation and habitat conversion, spread of invasive species and losses in biodiversity, and ecosystem goods and services.

- Accelerating sea-level rise, especially at the increasing rates projected for the 21st century, may result in the loss of substantial areas of critical habitat for a variety of coastal species. Both aquatic and terrestrial coastal ecosystems may see growing problems with invasive species.

- Sea-level rise will result in salt water intrusion into fresh water resources near the coast and reduce the amount of fresh water available for plants, wildlife, and competing agricultural and metropolitan uses.

- The preservation of healthy, resilient ecosystems with a rich plant and animal biodiversity is critical to the health, safety, and welfare of human populations. Human development has already reduced, degraded, and fragmented natural communities. This alone threatens the survival of individual species and some rare ecosystems.

Biodiversity and Habitat Adaptation Strategies

Introduction

The impacts of climate change will be significant and far reaching; requiring coordinated and targeted efforts to protect California's biodiversity. The adaptation strategies developed for this document provide a roadmap of actions that help maintain and restore processes that enhance ecosystem function and protect California's rich biodiversity. Existing stressors such as growth and development, water management conflicts, invasive species, and other widespread stressors identified in California's Wildlife Action Plan will act synergistically with climate change.[19] Investing and implementing these strategies will increase the capacity to deal with uncertainty and ensure that California's natural resources are maintained for generations to come. The state agencies that participated in the Biodiversity Sector Working Group (Department of Fish and Game and State Parks) developed the following strategies and are committed to implementing these strategies as capacity and resources allow. The strategies detailed in this document are part of a more detailed effort that can be reviewed on the Department of Fish and Game's climate change web page.[20] Please note that the strategies developed for this document generally address all natural areas above high tide. The continuum of habitat below high tide includes bays, estuaries, coastal wetlands and

Climate Change Adaptation Strategies to Conserve California's Biodiversity

- Create a large scale well connected, sustainable system of protected areas across the State.
- Manage for restoring and enhancing ecosystem function to conserve both species and habitats in a changing climate.
- Adjust management actions as appropriate for threatened and endangered species
- Prioritize research needs and pursue collaborative partnerships with the research community to ensure that the best available science is informing management actions.
- Re-evaluate existing policies and programs to incorporate climate change and seek regulatory changes as appropriate
- Pursue endeavors that will support implementation of the strategies including funding, capacity building, collaborative partnerships, and education and outreach.

open ocean waters were not included (for additional information see the Oceans and Coastal Resources chapter).

The Biodiversity/Habitat adaptation strategies provide a range of goals and objectives to help conserve biodiversity in the face of a changing climate. Detailed planning and subsequent actions are needed to implement these strategies. Before meaningful action can be undertaken, the Departments under the Natural Resources Agency should evaluate existing programs and projects that might contribute to the overall goals detailed in the following strategies and actions and carefully examine adaptation strategies in other sectors that may enhance or detract from the facilitation of biodiversity adaptation. Examples include long-term collaborative efforts that will help the state reach its goal of preserving and sustaining the largest possible array of biological diversity and habitat in all ecological regions of California. In the face of a changing climate it is imperative that Departments work to maintain healthy, connected, genetically diverse populations; improve and enhance ecosystem function of existing habitats; reduce non-climate stressors on ecosystems; develop adaptive management models for game and commercial species management; and adopt adaptation approaches that reduce risks to species and habitats while providing adequate time for species evolution and development if appropriate.

At the heart of these strategies is the need to create and maintain a network of reserve areas across the state that builds on existing conservation investments (e.g., acquisitions, easements), and provides refuge areas, and aids the movement of species within reserve areas as they adjust to changing conditions associated with climate change. Establishing a system of priority sustainable habitat reserves should provide for protection of habitat in all nine ecological bioregions identified in California's Wildlife Action Plan. Reserves should represent to the extent practical all aspects of ecosystem structure, composition, and function within aquatic, terrestrial, and near-shore marine habitats. In addition, any effort to establish a system of priority reserve areas should follow the basic principles of reserve design that will provide protection for species in the interim before species migration/movement due to climate change is wholly understood. In the future, a reexamination of the reserve system and species movement must take place and modifications for future protected areas identified.

The reserve system is intended to provide connectivity for species movement between current and future suitable habitats, while also accommodating range shifts of regionally-limited native plant species, and offering protection from catastrophic loss (e.g., through fire, flood, disease, invasive species). Management and restoration efforts on the network of reserve areas should be elevated in priority and focus on reducing the environmental stressors on plant and animal species and habitats.

Reserve system areas should be identified in the near-term for use in current and future land use planning efforts. It is important to acquire and protect habitat linkages found within and around designated reserve areas. Other important acquisitions may include acquiring fee title or conservation easements that focus on but are not limited to the following parameters: (1) increase soil, latitudinal and elevational gradients, (2) accommodate movement and migration of multiple endemic species, (3) reduce outside threats by improving reserve boundary configuration, and (4) protect evolutionary hotspots. Individually or collectively all these measures increase the overall protected area and provide for greater heterogeneity.

Identifying, improving, and connecting these reserve areas will help maintain and increase ecological integrity and provide healthy, resilient habitat and refuge areas to help species persist in a changing climate. For some species these areas may allow them to adapt to new conditions associated with climate change. Adapting to climate change through evolutionary change is an important factor affecting the fate of many plant and animal species. The success of the strategies identified in this document will be in part driven by when and how species may adapt or adjust to their surroundings. A better understanding of natural rates of adaptation through evolutionary change may permit effective management strategies that will help species persist and guide future conservation activities and investments. Species are pushed more rapidly to change where strong natural selection is working in a single direction. However, it is unknown if a single climate change factor will be strong enough to push rapid adaptation. For example, higher temperatures and drought stress may not exert similar selection pressures. Rapid evolutionary change provides a greater chance of species survival and is an important factor in establishing strategies for adaptation of biodiversity and habitat.

Adaptation Strategies and Actions

Over the last year the Department of Fish and Game and California State Parks have made climate change a priority in addressing the complex and large scale challenges needed for conserving biodiversity and habitat. Both of these Departments are an important part of the climate change solution and are working collaboratively with stakeholders to create strategies for addressing climate change impacts while responding to public needs. Initial planning efforts will lay the ground work for achieving the goals of these strategies as efforts are made to help species persist in a changing environment. As a first step, the Department of Fish and Game and California State Parks are committed to building upon the existing frameworks and programs, addressing internal policies related to regulatory responsibilities, and communicating openly with our partners and the public.

To this end, the Department of Fish and Game has created a new climate change advisor position to coordinate the Department's activities. Efforts are also underway at California State Parks (pending available funding) to develop a similar staff position. To meet the growing activities surrounding climate change, existing staff have been tasked with new climate change responsibilities and in some cases have been redirected to work on climate change issues.

The following climate adaptation strategies include both near-term actions which have been either identified, proposed, initiated, or can be completed by 2010. The long-term actions include those recommendations that will require additional collaborative efforts with multiple state agencies, as well as sustainable funding and long-term state support.

Adaptation Strategies and Actions

Strategy 1: Establish a System of Sustainable Habitat Reserves

The intent of this strategy is to identify and improve a statewide landscape reserve system to protect the maximum number of representative plant and animal species in California. The system should include relatively large (e.g., 150,000 plus acres), if possible, reserves in all ecological regions. This size should be adequate to sustain most species populations. Reserves should include federal, state, local and nonprofit protected habitat areas and matrix lands consisting of working landscapes (i.e., industrial timberland, agricultural lands, and rangelands) conservation easements, and mitigation lands. Each reserve should include a core area(s) of protected, heterogeneous habitat, including representative aquatic and terrestrial environments, owned and managed by a land managing entity.

<u>Near -Term Actions:</u>

a. **Organization of Collaborating Entities** – Initiate the development of a working structure that would include a facilitator and key entities (including a scientific panel) that will work together to identify a statewide reserve system and provide scientific expertise. Participants should be from the major land management and acquisition entities around the state, and include but not be limited to the State Department of Fish and Game, State Parks, State Coastal Conservancy, the National Park Service, U.S. Forest Service, U.S. Fish and Wildlife Service, academia, the Nature Conservancy and other conservation partners. (See Strategy 4.a)

   i. **Incorporate Latest Science** – Participants identified in strategy 1a should establish policies, priorities, and actions based upon the best available science and incorporate new scientific information into adaptive strategies (iterative approach) when available. Give research priority to monitoring keystone and other selected species and their adaptation or movement relative to reserves and other protected lands

ii. **Incentives for Private Conservation** – Participants identified in strategy 1a should provide, where feasible, incentives for the conservation of private lands and working landscapes to prioritize those at greatest risk.

b. **Best use of California's Wildlife Action Plan (Action Plan)** – The Action Plan is already proving to be an important blueprint for how the Department of Fish and Game will address future and current climate change challenges and will play a significant role in identifying a course of action.

c. **Setting Priorities for Conservation** – The Department of Fish and Game's Areas of Conservation Emphasis (ACE) mapping effort involved a statewide prioritization of areas considered to be of highest conservation value. The ACE effort is still in its preliminary mapping phase but is intended as a tool to directly support efforts to create a system of priority sustainable habitat reserves across California. In addition, the ACE can be used in conjunction with other mapping efforts to identify areas overlooked within biological subregions to ensure representative examples of every ecotype have been accounted for. This effort will also help identify linkages and corridors that will help aid species movement and migration. The Department of Fish and Game is committed to continuing coordination with our conservation partners as the final ACE maps are developed and informing all levels of government to better build collaboration and focus resources to the highest priorities.

Long -Term Actions:

d. **Update Existing Statewide Priorities** – Each entity in the above strategy should consider updating existing statewide planning priorities as appropriate to contribute to the design of a state reserve system. Statewide planning efforts include California's Wildlife Action Plan, Areas of Conservation Emphasis mapping effort (Department of Fish and Game), Natural Communities Conservation Planning (Department of Fish and Game), key and representative large natural parks (DPR), and statewide portfolio areas (TNC (The Nature Conservancy)).

e. **Design Reserve** – Collaborating entities should use public ownership and other protected area maps and priority areas in efforts to design reserves in all ecological regions.

f. **State Agency Review** – Review of draft reserves and the connectivity corridors should take place with key state agencies and their associated departments such as the California Natural Resources Agency, the Department of Transportation, the Department of Food and Agriculture, CAL FIRE, and the Department of Water Resources to ensure the adaptation plans from each department are complementary. Where synergies exist, focus would be on utilizing resources efficiently. Where potential conflicts in plans and their implementation exist, solutions should be negotiated to provide maximum flexibility for adaptive responses.

g. **Regional Review** – Review of draft plans for location of reserve areas should take place with key regional conservation planning groups in all regions. In addition, for each reserve participants should assess risk of habitat conversion, general condition and integrity, methods for land protection, and public access.

h. **Ratification** – Final design should be adopted by state and federal land management and acquisition agencies of the California Biodiversity Council. In order to better facilitate improvement and focus of the reserves over time, lead agencies should be identified for each reserve.

i. **Develop implementation incentives for participation by private landowners and local land use agencies** – Pursue incentives to increase participation in implementation by private landowners and regional and local land use authorities.

j. **Improve Reserve System Functionality** – Support research that indicates how to improve ecological integrity in reserve areas through acquisition or other forms of land protection that do the following: provide internal and external connectivity, increase soil elevational or latitudinal gradients, protect private lands from habitat conversions, enlarge the reserve consistent with endemic species movement, improve configuration of protected lands, and protect evolutionary hot spots.

k. **Adaptive Management-Review of Reserve System** – Periodically over the next 50-100 years the state will need to evaluate and review the long-term success of the Statewide Reserve System in preserving species and new habitat configurations associated with climate change. Determine degree of success of reserves and their improvements in light of keystone species movement, and adopt new strategies, e.g., modifications to reserve system as appropriate.

l. **Remove Federal Barriers** – Pursue modifications to laws, regulations and practices that provide barriers to linking protected areas especially those that impede the National Park Service, U.S. Forest Service and U.S. Fish and Wildlife Service from land acquisition that creates important landscape linkages and improves the reserve system beyond Congressional boundaries and encourages federal assistance that would strengthen the landscape reserve system.

Strategy 2: Management of Watersheds, Habitat, and Ecosystem Restoration

Enhance ecosystem function and adaptive capacity of California's natural resource lands. These actions should include, but are not limited to restoration of ecosystem functions and the reduction of environmental stressors on plants, animals, and habitats.

<u>Near -Term Actions:</u>

a. **Integrate Climate Change into Field Management** – Each land managing entity in the state should commit to reviewing and modifying current land and resource management objectives and practices to reduce environmental stressors and improve watershed conditions and ecosystem services on major holdings.

b. **C*alifornia Wildlife Action Plan (Action Plan)*** – Local, regional, and state wide land use and conservation plans should incorporate important regional actions to improve habitat and animal populations identified in the Action Plan. These actions should be considered priorities for implementation of stewardship efforts.

c. **Use and Improve Existing Conservation Efforts** – Department of Fish and Game's Natural Communities Conservation Program, Areas of Conservation Emphasis and mitigation banking should be continually supported as effective methods of identifying and protecting priority habitat areas. With appropriate resources these programs could use dynamic habitat-based models to improve identification of conservation areas.

d. **Field Restoration and Improved Protection** – Managers of conservation lands, including working landscapes, should continue restoration and other land stewardship practices. State and federal agencies should seek resources and expertise that will help them expand capacity to reduce environmental stressors, improve watershed conditions and restore ecosystem services on priority lands Reducing stressors includes but is not limited to:

i. Eliminating or controlling invasive species
ii. Restoring natural processes as appropriate
iii. Maintaining natural disturbance regimes
iv. Reduce unnatural sediment flows by improving drainage and maintenance of unpaved roads
v. Remove barriers to terrestrial and aquatic species movement
vi. Reduce risks of catastrophic wildfire
vii. Reduce and/or control pollution from runoff and flooding.

e. **Restore Aquatic Habitat** – With appropriate resources prioritize conservation and management actions on aquatic systems (including but not limited to associated floodplains, riparian zones, springs, and marshes) for monitoring and restoration efforts that will reduce stress on species resulting from events associated with climate change (i.e., increased sedimentation from flooding events). Management actions to assist in the reduction of existing stressors include, but are not limited to:
i. Maintain and increase genetic diversity of all native anadromous spawning runs
ii. Protect cold water resources
iii. Maintain habitat complexity
iv. Connect river/streams and floodplains
v. Protect high elevation alpine meadows, springs, and riparian areas
vi. To the extent possible limit interaction between wild and hatchery fish
vii. Temper unusual high and low flows
viii. Restore estuaries, sloughs and marshes

Long-Term Actions:

f. **Restoration Cost/Benefit Assessment and Climate Change** – Develop guidance for restoration practitioners to determine whether the objectives of large-scale restoration project take into account climate change scenarios and encourage the use of risk analysis to inform project planning and implementation.

g. **Managing Endemic and Other Priority Species** – Identify movement patterns of key species, especially latitudinal and elevational movement patterns in order to inform restoration and other stewardship activities that will aid in the conservation and management of species and habitats.

h. **Minimizing catastrophic events and habitat conversions** – Develop management recommendations that minimize habitat conversions and other large scale losses from catastrophic events, including crown fire, flooding, invasive species, diseases, pests and pathogens.

i. **Establishing Priorities** – Develop criteria for determining where limited conservation resources should be placed in order to have the most benefit.

j. **Water: Enhance and Sustain Ecosystems** (see also Water Management Chapter)
i. Water management systems should protect and reestablish contiguous habitat and migration and movement corridors for plant and animal species related to rivers and riparian or wetland ecosystems.
ii. Flood management systems should seek to reestablish natural hydrologic connectivity between rivers and their historic floodplains.
iii. The state should work with dam owners and operators, federal resource management agencies, and other stakeholders to evaluate opportunities to introduce or reintroduce anadromous fish to upper watersheds.

iv. The state should identify and strategically prioritize for protection lands at the boundaries of the San Francisco Bay and Sacramento-San Joaquin Delta that will provide the habitat range for tidal wetlands to adapt to sea-level rise.
v. The state should prioritize and expand Delta island subsidence reversal and land accretion projects to create equilibrium between land and estuary elevations along select Delta fringes and islands.
vi. The state should consider actions to protect, enhance and restore upper watershed forests and meadow systems that act as natural water and snow storage.

Strategy 3 - Regulatory Requirements

<u>Near-Term Actions:</u>

a. **CEQA Review/Wildlife** – The Departments within the Natural Resources Agency will continue to use the California Environmental Quality Act (CEQA) process to address the climate change impacts from projects on wildlife, including cumulative impacts.

b. **CEQA Review/Department Guidance** – The Department of Fish and Game will initiate the development of internal guidance for staff to help address climate adaptation and to ensure climate change impacts are appropriately addressed in CEQA documents

<u>Long-Term Actions:</u>

c. **Adaptive Capacity/CEQA Thresholds** – Based on climate change scenarios, the Department of Fish and Game should work to develop thresholds of significance for the adaptive capacity of species related to any direct, indirect and cumulative impacts of projects.

d. **Local Government Collaboration** – State Agencies that have regulatory authority and the Governor's Office of Planning and Research (OPR) should work with local land use planners and encourage local governments to adopt climate change adaptation actions for conservation, land use, research and regulatory measures.

e. **Sustainable Funding Mechanisms** – Achieve consistency in state and local regulations, general plans, and ordinances <u>and</u> develop sustainable funding mechanisms to support climate change planning efforts that focus on biodiversity conservation.
   i. The Natural Resources Agency and appropriate Departments should review and make recommendations to amend regulations to achieve consistency. This could be done through the Strategic Growth Council (SGC).
   ii. The state could work with local governments to develop consistency between state goals and local general plans and ordinances.
   iii. The SGC could develop funding programs to institute sustainable funding mechanisms to support climate change planning. The SGC may need to propose legislation to institute those funding mechanisms.

f. **Climate Change Models** – The state should continue to support climate change research and modeling efforts that support conservation and management of biodiversity in a changing climate. These kinds of modeling activities might include but are not limited to flow requirements for fish bearing streams that will help the Department of Fish and Game dedicate new instream flow requirements and develop new policies to address variances.

Strategy 4 - Research and Guidelines

<u>Long-Term Actions:</u>

a. **Establish a Permanent Biodiversity Research Team** – Appoint a permanent team of researchers and land managers to ensure that the best available science is used in management, restoration, and species protection. This team will be responsible for ensuring that state funded research is properly reviewed, annotated, and made publicly available to the conservation community and land use planners. Team activities and associated deliverables shall incorporate an open and transparent process that encourages stakeholder participation.
   i. **Develop a technical Scientific Panel to facilitate credible use of climate, ecosystem and species data to inform planning** – Developing a new approach to reserve design for adaptation to climate change will require increased sophistication of the use of data. A Science Panel should be formed to determine data and criteria for the use of data as inputs into the planning process. The Science Panel would be formed of scientists from academia, state and federal agencies and non-profit organizations. This team will determine selected plant and animal species for long-term monitoring and help identify and establish monitoring protocols with objectives of determining rapid evolution if appropriate, range shifts that will inform adaptation efforts, or other key information that will inform management actions.

b. **Climate Change Monitoring** – With appropriate resources, Department of Fish and Game along with other sister state agencies should work together to develop a statewide, long-term monitoring effort that evaluates climate related changes affecting indicator species, populations, communities and ecosystems.

c. **Link Climate Change Science to Climate Adaptation** – Save the Redwoods League and the CA Natural Resources Agency should track and monitor old growth forest responses to climate change and use the information to establish baseline records for potential landscape-level impacts.

d. **Prioritize Reserve System Related Research**

e. **Evolutionary Development** – While climate change and its impact on species are taking place rapidly, evolutionary change is generally unable to keep pace. However, recent research on genetics and evolution, illustrate examples where rapid change within generations is enabling species to adapt to new conditions. For example, commercial takings of larger, older individuals within populations have led to rapidly developed new survival characteristics in snakes and ocean fishes. Recent studies in the field of evolutionary biology have demonstrated rapid change during embryonic development of some fish and snakes. Research in the field of evolutionary biology will provide significant information to aid adaptation strategies in the future and should be integrated and funded to the extent possible.

Strategy 5 - Education and Outreach

<u>Near-Term and Long-Term Actions:</u>

a. **Public Outreach** – Given climate change and its associated impacts a commitment to ongoing public communication and outreach is essential, and should articulate the role of organizations in the protection of biodiversity.

b. **Public Interpretation and Classroom Education** – A public education campaign on interpretation and climate change, developed by California State Parks includes ten priority components, and will help the 85 million visitors each year understand climate change. Elementary schools will be offered three programs that teach climate change, given the availability of funding. The Department of Fish and Game should pursue similar outreach and education initiatives to inform the public regarding the effects of climate change on natural environments and species.

Strategy 6 – Implementation of Adaptation Strategies

<u>Near-Term and Long-Term Actions:</u>

a. **Policy Development** – All state agencies should review existing policies, criteria, and directives to initiate adaptation measures in response to climate change impacts.

b. **Capacity and Continuity** – In order to accomplish and maintain actions associated with the adaptation strategies, new funding sources should be identified to support new full time permanent civil servant positions that are dedicated to climate change adaptation.

c. **Success Measurements** – Establish quantifiable and qualitative near-term targets, mid-term and long-term milestones to measure success.

d. **Implementation Timing** – The Natural Resources Agency should convene a group of stakeholders and state agency staff to identify sustainable funding for climate change adaptation, prioritize recommendations and opportunities for securing funding.

e. **Adaptive Management** – Adaptive management is a key element of implementing effective conservation programs especially in light of the uncertainties associated with climate change related impacts on natural resources.

f. **Cross Sector Cooperation** – Interagency cooperation and collaboration are critical to the implementation and long term success of the strategies particularly in regards to the overlap between biodiversity and habitat concerns and all other sectors of this report. In addition, this same spirit of collaboration needs to be extended to other partners and stakeholders that can provide the data, research, and support to help achieve these goals.

VI. Ocean and Coastal Resources

Introduction

Approximately 85 percent of California's residents live and work in coastal counties; these populations will be at risk from a range of climate impacts that are specific to these regions.[1] California's coastal areas are home to unique and threatened ecosystems that offer unmatched recreation and tourism opportunities for people, provide invaluable habitat for rare species, and buffer coastal communities from flood and erosion. Yet, between 1980 and 2003, California's coastal population grew more than any other state's coastal population, increasing by a total of 9.9 million people, or 1,179 persons *every day.*[2] By 2025, the coastal population is expected to grow – albeit at a slower rate – to over 32 million people.[3] Along with people, infrastructure and assets are also concentrated along the coast. According to recent estimates developed for the 2009 California climate change impacts assessment, a 100-year flood event after a 1.4 meter (55 inches) sea-level rise will put 480,000 people at risk and nearly $100 billion in property.[4] In addition, California residents and out-of-state visitors make well over 500 million visits to the state's ocean beaches every year. People go to the coast to enjoy sun and sand, the vistas, and the unrivaled diversity of plants and animals that inhabit the region. All of these visits contribute greatly to California's ocean-dependent economy, which is estimated to be $46 billion per year.[5]

In 2006, the California Climate Change Center reported a historic sea-level rise of 7 inches in the last century and projected an additional rise of 22–35 inches by the end of this century. Since that time numerous other studies have published projected ranges of 7–23 inches,[6] 20–55 inches,[7] and 32–79 inches[8] of sea-level rise for this same period, with the differences in these projections attributable to different methodologies used and how well or whether glacier ice melt is included in the calculations. This report uses the 20-55 inch projection, as it was the best available science at the time of the 2009 impacts assessment. Future sea-level rise estimates will vary based on future GHG emissions. Much of the damage from this accelerated sea-level rise will likely be caused by an increase in the frequency and intensity of coastal flooding and erosion associated with extreme weather events and storm surges. In addition to sea-level rise, California's coastal and ocean resources are expected to experience additional dramatic changes. These include more severe atmospheric events (e.g., El Niño events); changes in ocean chemistry (e.g., temperature and pH) and estuarine chemistry (e.g., temperature, pH, and salinity); and changes in ecosystem processes (e.g., nutrient upwelling).

While the exact future of the coast is uncertain, one thing is clear: we're going to have to change the way we think about managing our natural assets and our human development. Existing laws (such as the California Coastal Act) provide state and local governments with tools for addressing the effects of climate change, but also impose some significant limitations. Laws written in and designed for the 20th century will need to be updated to reflect new ideas about climate change in the 21st century.

Californians will need to make tough decisions about which critical assets we want to protect, which ones can be relocated, which ones will have to be removed, and what is economically reasonable. Development and land-use is already putting stress on coastal ecosystems and resources, constraining their natural ability to adapt to a highly dynamic environment. New development along the coast should be designed and sited to anticipate expected sea-level rise, minimize future hazards, and maintain the biological productivity of the coastal environment. Yet, it will not always be possible to achieve the multiple goals of continued development, protection of critical infrastructure, sustained coastal recreation, and ecosystem protection. For example, shoreline protection structures negatively impact beach access, beach size, shoreline processes, recreation, tourism, and coastal habitats. Ultimately, when these goals are in conflict there will likely be winners and losers. We need to recognize this fact and develop priorities and the regulatory authorities that will allow decisions to be made in a reasonable manner that takes into account numerous factors and interests.

Future Climate Impacts to Oceans and Coastal Resources

A. Increased Temperature and Extreme Events

Air temperatures are expected to rise in coastal California at a slower pace than inland areas due to the cooling influence of the Pacific Ocean.[9] This may draw greater numbers of Californians to the coast. The implications of this possible migration for the economy, housing market, transportation infrastructure, coastal ecosystems, and quality of life have not been assessed to date but could be significant.

Ocean water temperatures will rise as air temperatures rise, causing changes in marine and coastal species behavior and distribution. Species within California's coastal and ocean environments are adapted for life within a particular range of temperatures.[10] An increase in water temperature can affect the metabolism, growth, and reproduction of stressed aquatic species.[11] Temperatures above or below optimal range can be lethal or affect an organism's metabolism, growth, and reproduction.[12] As such, temperature is one of the primary environmental factors that determine the geographic range of a species.[13] More shallow coastal waters (e.g., bays and estuaries) will warm sooner than the deeper parts of the oceans, thus warming temperatures should have a direct impact first in the coastal ocean, including bays, estuaries, lagoons, and wetlands. One direct impact of changing water temperatures is a change in coastal water quality because warmer water holds less oxygen. In addition, changes in upwelling will alter nutrient cycling; and absorption of atmospheric CO_2 by the surface waters will alter the acidity (measured in pH).

Increases in water temperatures off the coast of California have already led to a shift in the geographic range of species. As atmospheric and ocean temperatures continue to rise, species that currently have a geographic range from Point Conception south to the Mexican border will begin to shift their geographic range northward up the coast to find ocean temperatures within their physiological range. This has already been observed with the Humboldt squid that used to be an occasional visitor and is now a permanent resident in central California's coastal waters.[14] Just as on land, non-native/invasive species will migrate from more southern areas adding further displacement pressure on native species and taking hold in ocean and coastal ecosystems disturbed by climate change.[15]

Ocean and Coastal Resources Impacts due to Warming

- Population Changes in Coastal Areas Anticipated
- Public Health Education and Planning Needed for Extreme Heat
- Relocation of Marine Species and Southern and Exotic Species May Become Invasive
- Changes in Marine Food Systems (Upwelling and Nutrient Availability)
- Changes in Commercial and Recreational Ocean Fishery and Economic Impacts

Warming can also affect the ocean food web in indirect ways. El Niño patterns or Santa Ana winter wind intensity could significantly alter the nutrient cycling that underpins the marine food web and current species assemblages.[16] Santa Ana winds coincide with cool sea surface temperatures, upwelling, and a spike in biological activity. These winds are projected to decline in intensity, but it is not known how marine nutrient availability and food webs will change.[17]

Warmer ocean temperatures together with changed nutrient availability could result in a decrease in fish populations or a shift in the geographic range of harvested species.[18] During the 1997-1998 El Niño, California's commercial squid industry realized the vulnerability of the fishing industry to water conditions. Squid landings (the number or poundage of fish brought to shore by fishermen) decreased from 110,000 metric tons in 1996-1997 to just 1,000 metric tons over the course of the El Niño season.[19] Together with expected changes in coastal estuaries and wetland habitat resulting from sea-level rise (see below), commercial and recreational fish species may experience lower reproductive success and population decline.

While climate change may reduce or shift the habitable range of current fishery species, it may also allow new fish populations to move north. Some of these new species may become economically significant commercial or recreational fish populations (e.g., the Humboldt squid). The net effect upon the marine fishing industry is currently unknown and should be a subject of future study. Transitional costs (e.g., harvesting gear, marketing activity) to adapt to any new fishery would be expected. The health of California's fisheries will depend on each species' adaptive capabilities, the rate and complexity of interactions in the marine food web as a result of climate change, and the state's ability to implement measures to limit catches to sustainable levels and protect coastal habitats.

B. Precipitation Changes and Extreme Events

In California's coastal areas precipitation falls almost exclusively as rain, even in winter. Coastal fog also plays a large role in providing the moisture required for the maintenance of terrestrial coastal ecosystems; changes in coastal fog density will impact coastal forest types. A general pattern of a drying climate over the 21st century could result in rainstorms that are fewer in number, but greater in intensity; and less coastal fog. Changes to the timing and intensity of freshwater input from rainstorms could impact marine and near shore species.

Changing precipitation patterns will potentially increase the occurrences of flooding in coastal drainages. In coastal floodplain areas, runoff from land may coincide with the coastal storm surge (also higher due to sea-level rise) and lead to greater flooding risks in the immediate coastal zone.[20]

Less frequent but more intense rainfall patterns could have serious consequences on water quality. With an increase in frequency and intensity of wildfires,[21] increased runoff and flooding will remain a considerable risk and may also result in higher levels of pollution and sedimentation. The first flush of runoff during storm events is frequently heavily contaminated with toxins deposited on roads, driveways, parking lots and rooftops. Heavy runoff also offers a medium for infectious disease vectors to multiply and spread. Large amounts of runoff may overwhelm the capacity of sewers and sewage treatment plants to absorb and adequately cleanse waters before they reach coastal waters and beaches. Thus, both coastal and marine species and human health are at greater risk in the period following heavy storms (see the Public Health chapter). Infectious diseases in coastal waters and seafood may spread, and invasive species well-suited to more extreme conditions may flourish.[22] If the intensity of such extreme events increases, both human populations and natural habitats will be exposed to increased stresses and have less time to recover between occurrences.[23]

OCEAN AND COASTAL RESOURCES IMPACTS DUE TO PRECIPITATION CHANGES

- Higher Runoff and Flooding
- Flood Risks from Inland and Coastal Flooding
- Contamination from Sewage Distribution and Treatment Systems
- Health Risks from Contaminated Runoff

Potentially the most damaging extreme events in coastal California will be winter ocean storms. Past El Niño events have resulted in significant financial damages and exposed large numbers of people to flooding hazards. Climate change will likely exacerbate these impacts with larger waves and higher water levels. These storms will also affect coastal erosion and sediment transport patterns – larger and longer period winter waves have already been observed and may be a growing trend.[24] Additionally, there is the increased potential for extratropical storms (storms generated in the middle or high latitudes) in California as storm tracks move poleward with changing atmospheric conditions.[25]

C. Sea-level rise

Coastal Flooding and Permanent Inundation

California's coast is home to major population centers, many of which are situated in low-lying floodplains. Large numbers of people and important assets will be increasingly at risk from inundation during coastal storms as higher sea levels, high tides, storm surges, and inland flooding coincide.[26] Some low-lying areas will also be permanently inundated unless they are protected. Increasing rates of coastal erosion, beach loss, salinity intrusion into estuaries, and saltwater intrusion into groundwater will need to be addressed in future coastal land management decisions.

Figure 13: *Vulnerability of California Coastal Areas to Sea Level Rise*

Given the extent of high-value development already located in at-risk flood zones, California's coastal cities are not only at risk from storm-related inundation and flood-related damages, but also permanent property loss where land is eroded or permanently inundated. Currently, over 260,000 Californians live in areas designated as at-risk in a 100-year flood event (a one percent chance of occurring every year).[27] Coastal areas, and therefore the number of people exposed to risks from 100-year floods, will increase substantially as a result of sea-level rise in coming decades. Furthermore, what we currently define to be the 100-year flood today will occur much more frequently as sea level rises.[28]

Studies indicate that a 1.4 m (~5 feet) rise in the level of the San Francisco Bay by 2100 would place 33 percent more land at risk from flood-related inundation than is at risk from flooding today.[29] Without accounting for future growth and land use change, the amount of developed land at risk in the Bay area could more than double from current levels by the end of the century.[30] A majority of the structures at risk in that region are designated as residential property. The initial estimates of infrastructure in San Francisco Bay in 2100 indicate that over $62 billion worth of building and contents could be at risk.[31]

On the open ocean coast, challenges are similarly daunting. For example, the City of Santa Cruz has a levee system that protects some low-lying parts of the city against a 100-year flood. With a sea-level rise of approximately one foot, the anticipated 100-year flood event in Santa Cruz is expected to occur every 10 years, increasing the likelihood of storm-related inundation.[32] Over the entire California coast, over $100 billion worth of assets (buildings and contents) would be at risk from a 100-year flood in 2100 assuming a 1.4m (~5 feet) rise in sea level.[33]

Providing insurance coverage for coastal development under even a moderate sea-level rise scenario will be costly. One study estimated that the National Flood Insurance Program (NFIP), which provides backing for flood insurance in participating U.S. communities, will be confronted with an increase in insured property by 36 to 58 percent for a one-foot rise in sea level; and by 102 to 200 percent for a three-foot rise.[34] Not accounting for development and growth, this older study is indicative of the growing flood risk due to sea-level rise alone. The Federal Emergency Management Agency (FEMA) and the national treasury will more often be tapped to deal with growing flood damages in coastal areas unless insurance rates are increased to keep the program actuarially sound.

In addition to private property at risk, infrastructure is also at great risk from coastal flooding and erosion (see the Infrastructure chapter). A complex network of highways and roads, large ports, numerous airports, water supply canals, wastewater treatment facilities, and power plants are located in coastal areas, sometimes directly in floodplains, to support the region's and the state's economy and growing population. This coastal infrastructure is vulnerable to increased heat and flood events, potentially limiting the ability to deliver vital public services.

Impacts on transportation systems will include flooding of roads, railways, transit systems, and airport runways in coastal areas because of rising sea levels and higher storm surges. A substantial amount of ground transportation infrastructure is predicted to be at risk from sea-level rise by 2100, including 2,500 miles of roads and rails.[35] Such infrastructure is vital to the state's economy for both the movement of commercial freight and the ability of Californians to get to work and school. In the San Francisco Bay, the major airports of San Francisco and Oakland are near sea level and would require additional elevation, protection, or relocation to remain functional.

OCEAN AND COASTAL RESOURCES IMPACTS DUE TO SEA-LEVEL RISE

- Increased Risks of Coastal Flooding in Low-Lying Areas
  - More People and Assets - At Risk
  - Public Infrastructure - Increased Risk of Inundation
  - Levees and Structures - Require Retrofit
  - Coastal Wetlands - Potential Loss
- Increased Erosion of Beaches, Cliffs and Dunes
  - Private Property and Structures - At Risk
  - Beach Recreation and Tourism - May Decrease in Select Areas
  - Greater Expenditures for Beach Maintenance
- Increased Saltwater Intrusion into Coastal Groundwater Resources
  - Agricultural Land - Degraded by Saltwater

Municipal and industrial infrastructure would be directly and indirectly at risk from alteration of coastal resources due to climate change. Accelerated sea-level rise and storm-related flooding (from the coastal and the inland side) could threaten California's vital but aging levee and water transport system.[36] Additionally, water backflow could impair coastal water sanitary sewage systems during flood events.[37] Inundation of coastal infrastructure can also cause widespread pollution and contamination, jeopardizing marine and near-marine environments.

Wetland Loss

Increasing sea levels will submerge many low-lying portions of California's coastal wetlands. Of particular concern are coastal salt marshes, which have already been decreased by 91 percent from historical levels.[38] If vegetation and sediment accretion occurs rapidly, wetlands could maintain their present location and the wetland footprint would not decline. However, this scale of vertical accretion is not likely. For example, the average annual sediment deposition in the San Francisco Bay-Delta region is approximately 1 mm per year, which is insufficient given the projected sea-level rise of 2-3 mm (or more) per year.[39] The high degree of development and infrastructure placed in near-shore areas restricts the inland migration of wetlands in many locations, thus more coastal wetlands are likely to be lost.[40]

If wetlands are submerged by rising water levels, one consequence would be that wave energy would be less attenuated and erosional forces against upland levees, such as within San Francisco Bay, would increase.[41]

Additional potential impacts to wetlands due to sea-level rise include: changes to estuarine mixing, water quality, and carbon cycling; changes to upland habitats and sediment loads into downstream wetlands; and changes to wetland biological habitat, diversity, and changes in biological distribution which will potentially impact foraging opportunities and rearing habitats for key ocean species.[42]

Increased Coastal Erosion

In addition to coastal flooding, the rate of coastal erosion will likely also increase as a result of sea-level rise, which is suggested to accelerate over the 21st Century as the global climate warms. Loss or movement of beach sand and increased cliff and bluff erosion would jeopardize the stability of many coastal developments and recreation areas. The extent of this impact on California's coastline will vary by the type of coast, the width of the beach, and the presence or absence of protective structures. Damage to coastal infrastructure will be more severe where extreme wave conditions combine with elevated sea levels to impact unprotected and/or erodible coastal areas.

The U.S. Geological Survey (USGS) has developed a preliminary map in 2000 classifying areas of the U.S. Pacific coast based on their physical vulnerability to coastal change due to sea-level rise. Areas classified as "very high" risk are those that have already experienced significant erosion problems, and are concentrated mainly around the state's major bays including the Humboldt, San Francisco, and Monterey Bays as well as Los Angeles and San Diego.[43]

Increased coastal erosion will impact private property owners and beach-dependent sectors of the state's economy. Beach recreation and tourism generate the largest economic value of all economic sectors in the California coastal zone.[44] The economic value of beach recreation and tourism is of particular importance in southern California, as expenditures in just three counties in southern California accounted for 44 percent of the state's total tourism-related spending in 2007.[45] Many of the state's intensively used beaches are backed by seawalls, bulkheads, roads, parking lots, or other infrastructure, which prevents landward migration. These beaches will gradually be inundated or will be reduced in width as sea level rises, translating into a reduction on beach area. These physical effects of climate change could significantly decrease the viability and attractiveness of coastal tourism locations, including a shift in tourist attendance patterns among local beaches.[46] Such changes would generate either direct or transitional costs for the expanse of tourism-related businesses within the service economy of coastal California. The incidence of beach erosion and accretion at individual California beaches indicates a net negative effect from both gradual sea-level rise and extreme events on the order of an $8.6 million loss in total annual expenditures, and a $36.7 million decline in consumer surplus. However, these impacts will vary regionally.

According to one recent study for southern California, erosion rates are expected to accelerate by 20 percent for a sea-level rise of 39.4 inches (100 cm).[47] Several alternatives exist to deal with rising sea level and the issues of coastal erosion and inundation: armor, nourishment, and a planned retreat. Each will have tradeoffs in terms of impacts and costs, dictated by the magnitude of sea-level rise that is expected and the amount of property, infrastructure, or public resources threatened. Ten percent (or 110 miles) of the entire coast of California is now armored, and 33 percent of the shoreline of the four most southerly California counties has been hardened. We can expect more applications and pressure on permitting agencies (local governments as well as the Coastal Commission) to approve additional hardened structures in the future as sea level continues to rise.

Saltwater Intrusion

Sea-level rise and changes in the intensity of storm events could impact low lying coastal areas and result in the loss or inundation of coastal wetlands and dune habitat resulting in salt water intrusion and loss of fresh water resources for fish and wildlife. Sea-level rise will also adversely affect coastal water supplies through saltwater intrusion into coastal aquifers, potentially increasing the need for other water sources (such as desalination) to address coastal water shortages and impact groundwater resources tapped for irrigation.[48] Compounding the problem, low-lying farmland such as the Oxnard Plain and the Bay-Delta region may also be inundated with salt water.[49]

Ocean Acidification

Coastal ecosystems and the industries that depend upon them are being significantly impacted by increased acidification of the ocean due to increases in atmospheric CO_2 concentrations. Globally, the ocean absorbs 30-50 percent of the annual emissions of CO_2.[50] Higher CO_2 concentrations result in a reduction in the availability of the carbonate ion, a necessary precursor for the formation of calcium carbonate. This also results in a slight lowering of the pH of the water, making it more acidic.

Acidification has many impacts on marine life; it limits the growth and survival of species such as crabs, sea urchins, abalones, oysters and significant plankton species that have calcium carbonate shells and skeletons. The decreased survival of these calcifying organisms has rippling impacts on species that feed upon them (e.g., the loss of key plankton species will negatively impact the salmonids, seabirds and other species that feed on them). Commercially important shellfish species are likely to be negatively affected: under a moderate emissions scenario (750 ppm CO_2 by 2100), calcification rates of mussel and oyster species are predicted to decline by 25 and 10 percent, respectively, by the end of the century.[51] The declining pH levels also impact fertilization, development and metabolic function of many marine species, including kelp, which is an essential component of productive coastal ecosystems and a commercially harvested species. Acidification also affects the toxicity of a variety of substances and the biological availability of important nutrients and other compounds.

D. Risks for Ocean and Coastal Resources

To summarize the changing risks that California's ocean and coastal resources may be facing from climate change, the likelihood of occurrence of the projected consequences was qualitatively assessed. The resulting risk profile for California's oceans and coastal areas can be characterized as follows:

- Sea-level rise will increase the risks of coastal flooding in low-lying areas, inundating private property more frequently and exposing more people and more assets to flooding risks. Infrastructure, public facilities and industrial sites will also experience growing flooding risks. Levees, protective structures, and development may need to be elevated and flood-proofed to maintain protection.
- Threats to coastal wetlands are increasing. If wetlands cannot migrate inland due to man-made or natural barriers, wetland habitat will be lost.
- Sea-level rise will increase erosion of beaches, cliffs and bluffs in some areas, threatening private property and structures and causing economic losses to coastal recreation and tourism through reduction in beach area.
- Loss of wetland, beach, and other coastal habitat will negatively impact many fish, bird, and other species, and diminish biodiversity.
- Californians are likely to experience a more moderate increase in average temperatures in coastal areas than in inland areas due to the cooling effect of the ocean, yet may suffer disproportionately from extreme heat waves.

- Warmer water temperatures will cause shifts in the distribution of coastal and marine species; southern species may extend their range northward. Additionally, exotic species may become invasive in new areas and new pathogens may appear. Together with other climate-driven changes in wind patterns, upwelling, nutrient availability, and hard-to-predict changes in the marine food web, warmer water temperatures may cause recreational and commercial fishing species to decline in abundance or shift their range, leading to widespread economic impacts on these fisheries.
- Fewer, but possibly more intense, rainstorm events will produce high runoff and flooding. In the immediate coastal areas, such inland flooding may coincide with coastal flooding, posing particularly high risks to communities and structures in coastal floodplains.
- High runoff may overwhelm storm drains and sewage treatment plants, potentially contaminating coastal ecosystems and beaches.
- Sea-level rise will increase saltwater intrusion into coastal aquifers (groundwater resources), degrading agricultural land and coastal groundwater resources.

Ocean and Coastal Resources Adaptation Strategies

Introduction

The state agencies in the Climate Adaptation Working Groups (Ocean Protection Council, California Coastal Conservancy, California Coastal Commission, State Lands Commission, Department of Fish and Game, State Parks, and the Bay Conservation and Development Commission) contributed to the development of the following strategies and will be essential to the successful implementation of the strategies. Given the extent of the threats predicted by current climate models, sea level projections, and the considerable value of California's coastal lands, resources and developments, coastal planning in California must address adaptation to a variety of potentially significant outcomes of climate change. Preparing California's coastal infrastructure, industries and ecosystems for the impacts of climate changes will be an expensive endeavor. Decision-makers will need to make short- and long-term decisions to address future impacts that will include maintaining existing natural and human developments by protecting, rehabilitating, retrofitting, supplementing, and constructing these systems.

These decisions should be made using the following principles for guidance:
- California must protect public health and safety and critical infrastructure.
- California must protect, restore, and enhance ocean and coastal ecosystems, on which our economy and well being depend.
- California must ensure public access to coastal areas.
- New development and communities must be planned and designed for long-term sustainability in the face of climate change.
- California must look for ways to facilitate adaptation of existing development and communities to reduce their vulnerability to climate change impacts over time.
- California must begin now to adapt to the impacts of climate change. We can no longer act as if nothing is changing.

Adaptation to sea-level rise drives most of the Ocean and Coastal Resources adaptation strategies presented in this report. The priority strategy is for state agencies to avoid establishing or permitting new development inside future hazard zones in most cases if new protective structures would be necessary (strategy 1a). Additional strategies include (1) directives to promote innovative approaches to redesigning coastal structures, where feasible, that are resilient to the impacts of climate change and can serve to protect existing development in low-lying areas (strategy 1b), and (2) creation of guidance to local jurisdictions to help update local plans and make planning decisions in light of sea-level rise (strategy 2a).

All levels of government are encouraged to consider:

- Incentive programs to encourage property owners in high-risk areas to relocate or limit future development.
- Clustering new development in areas considered to have a low vulnerability to sea-level rise.
- Creating additional buffers and setbacks for new construction to minimize risks to people and property and to protect coastal resources such as natural habitat and recreational areas (see strategy 4c).

Critical coastal and ocean habitats and recreational areas should be protected and maintained to the extent feasible. The state should identify priority conservation areas and recommend lands that should be considered for acquisition and preservation. Future sea-level rise estimates should be considered during restoration efforts (i.e., grading levels for wetland restorations), and natural shoreline enhancements (e.g., species such as native oysters, eelgrass) should be designed to promote sedimentation and protect against shoreline erosion.

ADAPTATION ACTIONS

Adaptation Strategies and Actions

The Coastal Adaptation Working Group has identified the following priorities in addressing climate adaptation for California state agencies. The near-term actions referenced below are those actions that have been identified and which can be initiated or completed by 2010, if, in some cases, related statutory or regulatory changes are made. The long-term actions include those that will require support from that state and collaboration with multiple state agencies or that require significant legal or regulatory changes.

Strategy 1: Establish State Policy to Avoid Future Hazards and Protect Critical Habitat.

<u>Near -Term Actions:</u>

a. **Hazard Avoidance Policy** – State agencies should consider project alternatives that avoid significant new development in areas that cannot be adequately protected (planning, permitting, development, and building) from flooding due to climate change. The most risk-averse approach for minimizing the adverse effects of sea level rise and storm activities is to carefully consider new development within areas vulnerable to inundation. State agencies should generally not plan, develop, or build any new significant structure in a place where that structure will require significant protection from sea-level rise, storm surges, or coastal erosion during the expected life of the structure. However, vulnerable shoreline areas containing existing and proposed development that have regionally significant economic, cultural, or social value may have to be protected, and in-fill development in these areas should be accommodated. State agencies should incorporate this policy into their decisions, and other levels of government are also encouraged to do so.

b. **Innovative Designs –** If agencies do plan, permit, develop or build any new structures in hazard zones, agencies should employ or encourage innovative engineering and design solutions so that the structures are resilient to potential flood events or can be easily relocated or removed.

c. **Habitat Protection –** State agencies should identify key habitats that may require more protection as a result of climate change impacts and should plan additional buffer areas where necessary to allow for climate change induced phenomena, such as wetland migrating upland as sea level rises.

Long -Term Actions:

d. **Coordinate Policy Implementation** – State agencies should use outreach and incentive programs to promote hazard avoidance policies and sound management decisions for coastal habitat protection and development to all levels of government.

Strategy 2: Provide Statewide Guidance for Protecting Existing Critical Ecosystems, Existing Coastal Development, and Future Investments

Significant and valuable development has been built along the California coast for over a century. Some of that development is currently threatened by sea-level rise or will be threatened in the near future. Similarly, the coastal zone is home to many threatened or endangered species and sensitive habitats. We must acknowledge that the high financial, ecological, social and cultural costs of protecting everything may prove to be impossible; in the long run, protection of everything may be both futile and environmentally destructive.

Near -Term Actions:

a. **Establish Decision Guidance** – The OPC in close coordination with other state resource agencies should develop a statewide framework that can be used by state and local agencies as guidance in preparation of adaptation plans. This guidance should discuss current and potential regulatory frameworks and consider three key questions for helping to design and locate proposed or existing structures that may be threatened by sea-level rise:

1. Is the existing or proposed structure either necessary for the health, safety, or welfare of an entire region, or is it located within a hazard area for which protection will be provided because of surrounding high-value development?
2. Is it infeasible to relocate an existing structure or site a new structure outside the hazard area and still provide this health, safety, or welfare function?
3. Will relocating an existing or proposed structure provide environmental protection or recreational opportunities that may be otherwise lost if that structure is built or is protected along the coast?

Additional questions that should be considered in the preparation of the framework include:

- Is there a feasible "soft" protection solution (i.e., can a barrier beach or wetland be used instead of a seawall)?
- Will the protection approach, retrofit, or new design:
  - i. Be necessary to protect an existing structure threatened by erosion?
  - ii. Allow continuation of important natural processes, such as littoral drift, and avoid any impacts to neighboring habitats or structures?
  - iii. Provide a long-term solution to the threats caused by sea-level rise?
  - iv. Be resilient over a range of sea-level rise possibilities?
  - v. Provide broad protection to existing developed areas?
  - vi. Protect structures of high cultural or social value?
  - vii. Provide for a natural shoreline (i.e., can seawalls be designed to include habitat)?
  - viii. Be coordinated with proposed actions for other infrastructure in the same flood hazard area?
  - ix. Cost less than the value of the structure to be protected?
  - x. Provide mitigation for adverse impacts that cannot be avoided?

Long -Term Actions:

b. **Pilot Studies** – Develop pilot studies in cooperation with specific cities/state agencies that will examine the efficacy and utility of the framework highlighted above.

Strategy 3: State Agencies Should Prepare Sea-Level Rise and Climate Adaptation Plans

<u>Near -Term Actions:</u>

a. **Adaptation Planning** – By September 2010 state agencies responsible for the management and regulation of resources and infrastructure subject to potential sea-level rise should prepare agency-specific adaptation plans, guidance, and criteria, as appropriate.
   i. The Coastal Commission, the San Francisco Bay Conservation and Development Commission, the state and Regional Water Quality Control Boards, California State Parks, and the State Lands Commission should continue to develop adaptation strategies that can be implemented through their existing planning and regulatory programs.
   ii. The Coastal Conservancy, the Ocean Protection Council, and the Wildlife Conservation Board should continue to develop criteria to guide their financial decisions and ensure that projects are designed to consider a range of climate change scenarios.
   iii. The California Department of Transportation, State Parks, the Department of Water Resources, the Department of Fish and Game, the State Lands Commission, and other state agencies that own land and facilities along the coast should develop policies to guide them in land-use projects and the development of infrastructure in vulnerable areas in the future.
   iv. The aforementioned agencies should:
      a. Consider requiring applicants to address how sea-level rise will affect their project, include design features that will ensure that the project objectives are feasible and that the project will not be rendered unusable or inoperable over its lifespan, and that public access is provided, where appropriate.
      b. Prepare climate strategies, indicators, and thresholds that respond to changing ocean temperatures, air temperatures, and ocean acidification impacts. These strategies should include alternative management strategies that could be employed (i.e., aquaculture and fishing practices may change under lower pH conditions.)
   v. The Department of Insurance should develop regulatory policies to guide private insurers in dealing with properties in vulnerable areas.

<u>Long -Term Actions:</u>

b. **Adaptation Plan Updates** – State agencies should regularly update, modify, and refine these adaptation guidance documents and plans based on new information.

Strategy 4: Support Local Planning for Addressing Sea-Level Rise Impacts

<u>Near -Term Actions:</u>

a. **Public Outreach** – The Ocean Protection Council (OPC) in close coordination with other state ocean resource agencies should (beginning in Fall 2009) conduct public meetings within coastal communities to examine adaptive strategies available to state and local agencies to prepare for potential sea-level rise impacts. Strategies, tools, and information will be compiled and made publically available for use by local governments when updating their local and general plans.

b. **Funding Mechanisms** – The OPC should collaborate with state agencies to identify potential funding sources (i.e., AB32 or an amendment to Prop 218) for state agencies and local governments to undertake revisions to local plans.

c. **Local Government Guidance** – All relevant state agencies should collaborate with local jurisdictions to encourage them to consider the following strategies when updating plans:
   i. **Setbacks –** Mandatory construction setbacks can be imposed to prohibit construction and significant redevelopment in areas that will likely be impacted by sea-level rise within the life of the structure.
   ii. **Additional Buffer Areas** – Additional buffer areas can be established in some places to protect important cultural and natural resource assets.
   iii. **Clustered Coastal Development –** Coastal development can be concentrated in areas of low vulnerability and may reduce carbon emissions from transportation.
   iv. **Rebuilding Restrictions** – Rebuilding can be restricted when structures are damaged by sea-level rise and coastal storms.
   v. **New Development Techniques** – Building codes can be amended to require that coastal development incorporate features that are resilient to sea-level rise (e.g., require that development begin on the second floor).
   vi. **Relocation Incentives** – Federal, state and local funding or tax incentives to relocate out of hazard areas.
   vii. **Rolling Easements** – Policies and funding to facilitate easements to a) relocate developments further inland, b) remove development as hazards encroach into developed areas, or c) facilitate landward movement of coastal ecosystems subject to dislocation by sea-level rise and other climate change impacts.
   viii. **Engineering Solutions** – New engineering approaches will need to be applied to ports, marinas and other infrastructure that must be located on the shoreline to maintain their function as the sea level rises.

   The Governor's Office of Planning and Research will provide a guidance document in 2009 to address state land use planning.

d. **Amend Local Coastal Plans and General Plans to Address Climate Change Adaptation** – By 2011, or within one year after development of the tools or guidance necessary to support such amendments and if funding is secured, all coastal jurisdictions, in coordination with the Coastal Commission, should begin to develop amended LCPs that include climate change impacts; and local jurisdictions around San Francisco Bay should begin to update their general plans, in coordination with BCDC.

Strategy 5: Complete a Statewide Sea-Level Rise Vulnerability Assessment Every Five Years

<u>Long -Term Actions:</u>

a. **Vulnerability Assessment** – In coordination with all relevant state agencies, OPC should produce a coastal and ocean vulnerability assessment every five years that consolidates and builds upon existing efforts by the California Energy Commission and other agencies. Each new assessment will discuss the most recent knowledge about climate impacts to ocean and coastal resources, inventory coastal natural and man-made assets, and assess what is at risk (including an economic valuation).

Strategy 6: Support Essential Data Collection and Information Sharing

Research and data are needed to perform and update vulnerability assessments. Agencies should work in cooperation with federal partners to seek funding for the collection of essential data. The state should continue to establish baseline climate change data and common modeling assumptions so that planning actions in the different agencies are based on common information to the greatest extent possible.

Near -Term Actions:

a. **High-Resolution Mapping** – The state, in cooperation with federal partners, should immediately fund the collection of high-resolution topography and bathymetry mapping (i.e., LiDAR) to provide elevation information needed as a baseline for monitoring change, for the modeling of flood hazards, and to help identify and document habitats and ecosystems.

b. **Tidal Datum** – Monitoring on tidal datums should be maintained and expanded, including establishing additional tide gage stations. Tidal datums are used to measure local water levels and can project how global sea-level rise will be experienced at the local scale. These data are needed to determine the mean high tide and other reference points used in regulatory and legal settings.

c. **Ecosystem Research** – Research should be conducted on potential changes to ocean and coastal ecosystems, and species ranges, which are already changing - resulting in divergence in breeding and feeding behavior. Understanding ecosystem changes will be essential to future management decisions related to fisheries, species protection, and restoration projects.

d. **Coastal and Wetland Process Studies** – Research should be conducted to understand and model coastal, estuarine, and wetland circulation and sediment distribution and transport. This information is essential to successful wetland and beach maintenance, restoration, and nourishment projects.

Long -Term Actions:

e. **Decision Support** – The OPC should work with state ocean resource agencies and other appropriate partners (such as academia and nongovernmental organizations) to help provide the necessary data and tools to state and local agencies for decision support to protect development and habitat from sea-level rise.

VII. WATER MANAGEMENT

Introduction

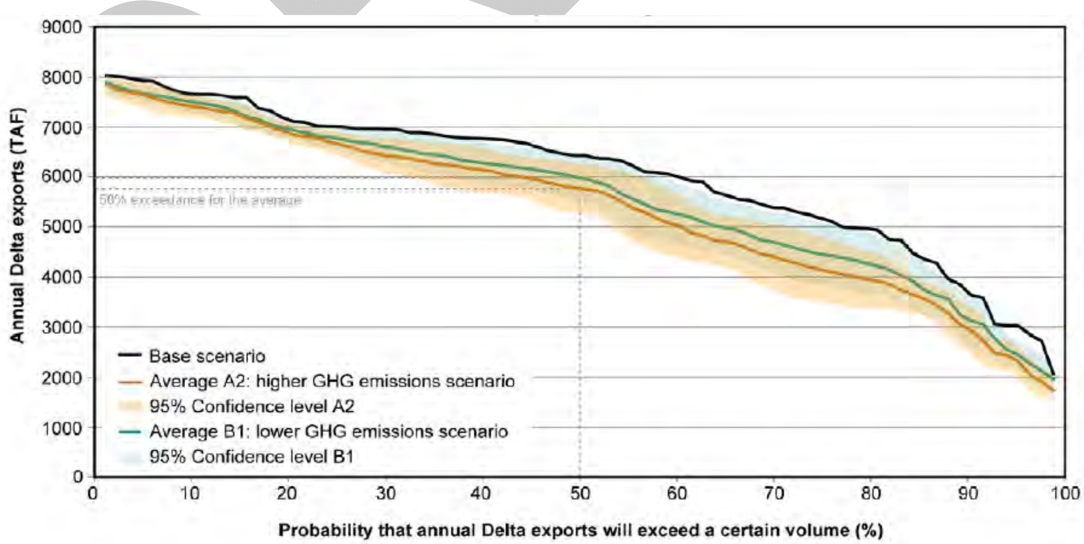
Water is the lifeblood of California's natural and human systems. For more than 200 years, California water and flood management systems have provided the foundation for the state's economic vitality, providing water supply, sanitation, electricity, recreation, and flood protection. However, the climate patterns that these systems were based upon are different now and may continue to change at an accelerated pace. These changes collectively result in significant uncertainty and peril to water supplies and quality, ecosystems, and flood protection.

Nearly 75 percent of California's available water supply originates in the northern third of the state (north of Sacramento), mainly from water stored in the Sierra Nevada snowpack. At the same time, 80 percent of the demand occurs in the southern two-thirds of the state.[1] California has been able to bridge the geographic distance between water supply and demand by building one of the most complex water storage and transport systems in the world to convey large quantities of water throughout the state.

However, drought conditions are likely to become more frequent and persistent over the 21st century due to climate change. Today, the effects of hydrologic droughts are increasingly being exacerbated by additional regulatory requirements to protect listed fish species, especially regarding water diversion from the Bay-Delta. For example, the hydrologic severity of California's present three-year drought is not remarkable in comparison to past three-year droughts, but drought impacts in the Delta export area are such that a statewide drought emergency has been proclaimed for the first time in California.

Population growth expected over the next few decades will lead to additional demand. Even without higher air temperatures and changing precipitation patterns over the next few decades, California's water supply problems would already be challenging. A portfolio of measures implemented at the local and regional level will be needed to meet these growing challenges.

Figure 14: *Using Mid-Century Climate Projections to Support Water Resources Decision Making in California*



Future Climate Change Impacts to Water Management

The state's water supply system already faces challenges to provide water for California's growing population. Climate change is expected to exacerbate these challenges through increased temperatures and possible changes in precipitation patterns. The trends of the last century – especially increases in hydrologic variability – will likely intensify in this century. We can expect to experience more frequent and larger floods and deeper droughts. Rising sea level will threaten the Delta water conveyance system and increase salinity in near-coastal groundwater supplies. Planning for and adapting to these simultaneous changes, particularly their impacts on public safety and long-term water supply reliability, will be among the most significant challenges facing water and flood managers this century.

WATER MANAGEMENT IMPACTS DUE TO WARMING

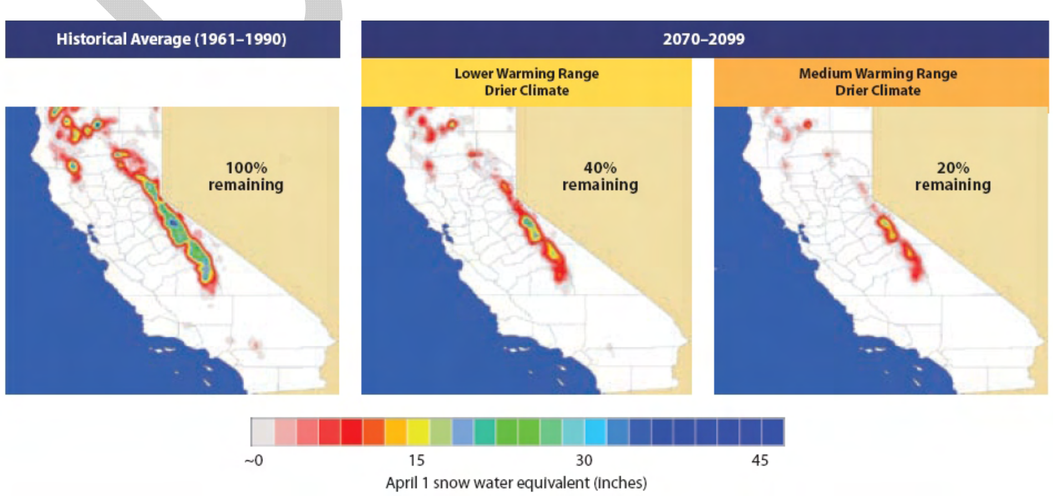
- Reduced Water Supply from the Sierra Snowpack
- Changes in Water Quality
- Increased Evapotranspiration Rates from Plants, Soils and Open Water Surfaces
- Moisture Deficits in Non-irrigated Agriculture, Landscaped Areas and Natural Systems
- Increased Irrigation Needs
- Increased Agricultural Water Demands Due to a Longer Growing Season.
- Increased Urban Water Use, at Possible Expense of Agriculture Water.

A. Increased Temperature and Extreme Events

Increasing average temperatures may have several impacts on water supply and demand, affecting California's farms, municipalities, and ecosystems.

First, increasing winter and early spring temperatures will cause earlier melting of the Sierra Nevada snowpack – the most important seasonal surface reservoir of water in California. Historically this snowpack has released about 15 million acre-feet slowly over the warming spring and summer months (one acre-foot provides the annual water needs of one to two families).[2] California's water storage and conveyance infrastructure gathers this melting snow in the spring and delivers it for use during the drier summer and fall months. This same infrastructure is also used for flood control in the winter and early spring by keeping lower reservoir levels. With earlier snowmelt and heavy winter/spring rains possibly coinciding, difficult tradeoffs may need to be made between water storage and flood protection.

Figure 15: *California Historical and Projected Decrease in April Snowpack (1961-2099)*



Increased underground storage of surface waters and increased groundwater withdrawal may potentially be used to ensure that future water supplies meet growing demands. However, groundwater balances in California are generally not well documented, with many aquifers contaminated, necessitating further study to assess the more widespread feasibility of groundwater storage.

In addition, climate change may make preservation and restoration of habitat more difficult. The ecological requirements of cold-water fishes provide an example. Climate change may warm rivers and streams, with less water available for ecosystem flow and temperature needs in spring and summer. In many low- and middle-elevation streams today, summer temperatures often approach the upper tolerance limits for salmon and trout; higher air and water temperatures will exacerbate this problem. Thus, climate change might require dedication of more water, especially cold water stored behind reservoirs, to simply maintain existing fish habitat. Climate change is also expected to raise sea level. As this happens, the brackish and fresh aquatic habitats of the Sacramento-San Joaquin estuary that are critical to many at-risk species will shift upstream and inland. Growing urbanization on the eastern edge of the Delta will limit opportunities to acquire or restore lands that would provide suitable habitat. Threatened and endangered species could be increasingly squeezed between the inland sea and the encroaching cities. Higher water temperatures also can accelerate biological and chemical processes that increase growth of algae and microorganisms, thereby creating an additional demand for oxygen in the water.[3]

Higher temperatures – especially in the summer growing season – increase evapotranspiration rates from plants, soils and open water surfaces. In a study conducted for the 2008 California climate impacts assessment, net evaporation from reservoirs was projected to increase by 37 percent in a warmer-drier climate, but only by 15 percent in a warmer-only scenario, reducing available supplies accordingly.[4]

While higher temperatures increase the water demand and use by plants, soil moisture decreases and reservoirs and/or groundwater reserves are reduced. Non-irrigated agriculture and landscaped areas, as well as natural systems, will suffer moisture deficits if natural water supplies are limited, and the risk of wildfires will increase. Elsewhere, irrigation will need to be increased if crop losses are to be avoided.[5] During extreme heat events livestock will require more water for drinking and cooling.

Finally, higher average temperatures extending over longer periods of the year will lengthen the growing season, thereby increasing the amount of water needed for non-irrigated plant growth, environmental water needs, and for the irrigation of crops and landscaped areas.[6] A recent study on water demand in California estimated agricultural and urban water demands under both a warmer-only and a warmer-drier climate change scenario using the CALVIN (California Value Integrated Network) model – a statewide model of the economic and engineering aspects of California's interconnected water supply system. Using these scenarios, the study found that agricultural water use would decrease by nearly 15 percent (4,070 thousand acre feet [TAF]/year) between 2020 and 2050 as urban demand increases and overall supply decreases by 7 percent.[7] Even assuming the implementation of water conservation and water efficiency measures to partially compensate for the expected reduction in supply, urban water demand is expected to increase by more than 10 percent (1,606 TAF/year) between 2020 and 2050.[8] The study also concluded that the agricultural sector is more vulnerable to water shortages than the urban sector; thus, water supplies to agriculture may be 20 percent below demand targets under the warmer-only climate scenario and 23 percent below demand under the warmer-drier scenario.[9]

B. Precipitation Changes and Extreme Events

Climate change can potentially alter California's historical precipitation patterns. While the state is expected to retain its Mediterranean pattern of dry summers and wet winters, along with significant year-to-year variability in total precipitation, some projections of the future involve worrisome changes for the state's water supplies.

Global climate models vary considerably in projecting precipitation patterns into the future. For planning purposes, eleven of the twelve simulations selected for the 2008 California Climate Change Impacts Assessment deliberately project a future marginally to considerably drier by mid-century, while only one simulation projects a slightly wetter future. In addition to the warming trend and the snowline moving higher, scientists expect that a growing proportion of winter precipitation to fall as rain instead of as snow, significantly reducing snow accumulation on April 1 (an important date in the hydrological calendar).[10]

The expected reduction in the Sierra snowpack is particularly troublesome for California water supplies, as it essentially functions as California's largest surface water reservoir. The state's agriculture, industrial and municipal users, and a wide variety of ecosystem functions, depend heavily on the stored water being released in the early dry months of the year.

Water Management Impacts due to Sea-level Rise

- Increased Stress on Sacramento-San Joaquin Delta Levees
- Saltwater Intrusion into Estuaries, Bays, and Coastal Groundwater:
  - Change Water Quality
  - Transform Ecosystems
  - Reduce Freshwater Supplies

Existing storage and conveyance facilities have been built and operated based on historical patterns of rain and snowfall. Over the last century, the average early spring snowpack runoff has decreased by about 10 percent, a loss of 1.5 million acre-feet of water. Using historical data in conjunction with climate and hydrologic models, the Department of Water Resources projects that the Sierra Nevada snowpack may be further reduced from its mid-20th century average by 25 to 40 percent by 2050.[11]

Water Management Impacts Due to Precipitation Changes

- Possible Precipitation Decreases - From 12-35 Percent Compared to Historical Annual Averages
- More Winter Precipitation Falling as Rain Instead of Snow
- Intense Rainfall Events - More Frequent and/or More Extensive Flooding
- Droughts - More Frequent and Persistent
- Possible Decreasing Water Quality:
  - Longer Low-flow Conditions
  - Higher Water Temperatures
  - Higher Contaminant Concentrations

Water supplies originating from outside of the state are also important. Rising temperatures and drier conditions have led to projections of decreasing volumes of water in another one of California's water sources, the Colorado River basin. Studies underway by the Western Water Assessment of the University of Colorado are seeking to reconcile the wide range of estimates in possible decreases – from -6 percent to -50 percent - in Colorado River flow by mid-century or later.[12] In late 2007, the Secretary of the Interior signed an historic Record of Decision for *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* that allows for more efficient operation of the reservoir system to reduce the potential frequency and magnitude of shortages. Through 2025, the period covered in the interim guidelines, the estimated risk of shortage to California is very small, thanks to the large volume of storage in the river basin, the high elevation of the runoff generating region of the upper basin, and the relative seniority of California water rights. Estimating the risk of shortages beyond that date is complicated by the uncertainties of future reservoir operations strategies and the disparate projections of runoff impacts.[13]

Figure 16: *View of Lake Oroville in 2005 (left) and November 2008 (right)*

Finally, California's hydroelectricity production relies on predictable water reserves. In 2007, nearly 12 percent of California's electricity was produced from large hydroelectric power plants, presently the state's largest source of renewable energy.[14] With snow falling at higher elevations, creating less snowpack, and melting earlier in the year less water is available for this source of power generation when it is most needed, during the warmer summer months. When several dry years create drought conditions, reservoir levels can be reduced to levels lower than those required for hydroelectric power generation.[15]

Extreme Rainfall and Flooding

California's current water systems are designed and operated to strike a balance between water storage for the dry months and flood protection during the winter and spring, when heavy rainstorms, runoff, and snowmelt can cause downstream flooding. While some climate models predict an overall drying of California's climate, at the same time there are also continued risks from intense rainfall events that can generate more frequent and/or more extensive runoff and flooding.[16] Additionally, periodic larger than historical floods are expected to occur, especially in the southern parts of the Sierra Nevada, where a transition from snow to more rainfall will occur.[17]

Flood peaks can increase erosion rates that results in greater sediment loads and turbidity while runoff from streets and farms can increase concentrations of pollutants.[18] Changes in temperature and precipitation could alter existing fresh water systems and an overall reduced availability of water for fish and wildlife. An increase in floods may amplify movement of pollutants and contaminants into previously pristine areas. Temperature and precipitation changes will affect a variety of aquatic species and may result in loss and degradation of sensitive aquatic ecosystems and potentially increase invasive species challenges. In addition, these changes will affect groundwater recharge and over drafting as well as hydropower and hatchery project operations, fish passage issues, and water diversion projects. Changes in composition and structure from precipitation and flow changes for riparian communities and conflicts over allocation of surface water could result in increased management conflicts between people and wildlife and will require communication and collaboration among managers.

C. Sea-Level Rise

The higher mean water levels from sea-level rise can exacerbate existing factors that threaten critical portions of the Sacramento and San Joaquin Delta levee system. This system extends over more than 700,000 acres and consists of a myriad of small natural and man-made channels bounded by levees to protect land and key infrastructure from floods.[19] If levees fail, water from San Francisco Bay would inundate agricultural land and some communities, damage infrastructure, affect ecosystems, enter California's freshwater supply, and change water quality.

Warmer storms and snowmelt may coincide and produce higher winter runoff from the watersheds, while accelerating sea-level rise will produce higher storm surges during coastal storms. Together, they increase the probability of Delta levee failures, breaking a critical link between water supply in the north and water users in the southern portions of the state.

Additionally, a drop in summer stream flows could affect the Sacramento-San Joaquin Delta water supply and ecosystems, both directly through low-flow conditions and higher stream water temperatures, and indirectly as saltwater intrudes further upstream from the Pacific Ocean. An increase in the penetration of seawater into the Delta will thus further degrade drinking and agricultural water quality and alter ecosystem conditions.[20] Holding back this salinity intrusion will require more freshwater releases from upstream reservoirs to maintain fresh water levels for municipal, industrial and agricultural uses, which in turn will further increase pressure on already scarce water resources.

D. Risks for Water Management

Higher temperatures, changes in precipitation patterns and sea-level rise all combine to exacerbate California's existing water supply challenges. Expected population growth alone would make it more difficult to meet growing water demands. With climate change the state's water crisis will worsen, overall increasing the risk of water shortages and flooding. To summarize the changing risks that California's water supply will face from climate change, the likelihood of occurrence of the projected consequences was qualitatively assessed. The resulting risk profile for California's water supply can be characterized as follows:

- Higher temperatures will melt the Sierra snowpack earlier and drive the snowline higher, resulting in less snowpack to supply water to California users. In addition, a growing proportion of winter precipitation will fall as rain instead of as snow. Snow accumulation on April 1 will be significantly reduced, and snowmelt will run off earlier, leaving less water stored for the dry months.
- By mid-century, most climate simulations used by the 2009 CAT report project marginally to considerably drier conditions in California. Water supplies originating from outside of the state (e.g., the Colorado River Basin and the Klamath River Basin) are also decreasing.
- Intense rainfall events, periodically ones with larger than historical runoff, will continue to affect California with more frequent and/or more extensive flooding.
- Droughts are likely to become more frequent and persistent in the 21st century.
- Streams may experience longer low-flow conditions with higher temperatures and higher concentrations of contaminants.
- Higher temperatures – especially in the summer and over a longer growing season – increase evapotranspiration rates from plants, soils and open water surfaces, including water reservoirs.
- Non-irrigated agriculture and landscaped areas, as well as natural systems will suffer moisture deficits if natural water supplies are limited, and irrigation will need to be increased if crop losses are to be avoided. Even with conservation and efficiency measures, urban water use is expected to increase.
- Storms and snowmelt may coincide and produce higher winter runoff from the landward side, while accelerating sea-level rise will produce higher storm surges during coastal storms. Together, they increase the probability of levee failures in the Sacramento-San Joaquin Delta.
- Saltwater intrusion into estuaries, bays, and coastal groundwater resources will diminish water quality, transform ecosystems and reduce freshwater supplies.

Water Management Adaptation Strategies

Introduction

Concerns over the availability, quality, and distribution of water are not new to California, but these concerns are growing and solutions are becoming more complex as water managers navigate competing interests and regulations to reliably provide quality water to farms, businesses, and homes, while also protecting the environment and complying with legal and regulatory requirements. Water adaptation strategies are primarily driven by the possibility of reduced future water supplies and increased flood threat brought about by climate change. While we are unlikely to know the full scope of climate change for many decades, we do know enough now to begin taking action strategically to adapt California's water management systems.

The Department of Water Resources (DWR), in collaboration with the State Water Resources Control Board, other state agencies, and numerous stakeholders, has initiated a number of projects to begin climate change adaptation planning for the water sector. For instance, the recent incorporation of climate change impacts into the California Water Plan Update is an essential step in ensuring that all future decisions regarding water resources management address climate change. As part of the Update, in October 2009 DWR released the U.S.'s first state-level climate change adaptation strategy for water resources, and the first adaptation strategy for any sector in California. Entitled *Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water,* the report details how climate change is already affecting the state's water supplies and sets forth ten adaptation strategies to help avoid or reduce climate change impacts to water resources. Because of the large role of local and regional water management, central to these adaptation efforts will be the full implementation of Integrated Regional Water Management (IRWM) plans, which address regionally appropriate management practices that incorporate climate change adaptation. These plans will evaluate and provide a comprehensive, economical and sustainable water use strategy at the watershed level for California.

> **North Coast Integrated Regional Water Management Plan (NCIRWMP):**
>
> Stakeholders on the North Coast are incorporating climate change into the NCIRWMP in many ways, including evaluating options for carbon sequestration, GHG emission reduction via large scale alternative energy generation and by reducing the risk of catastrophic wildfire, incorporating adaptation into local planning, water infrastructure and watershed restoration activities, and educating the public regarding the need for climate adaptation. In particular, there are substantial opportunities to incorporate climate adaptation into the NCIRWMP framework, many of which address multiple objectives of the IRWM program such as flood and stormwater management, water conservation, local planning, floodplain and habitat enhancement, and water supply reliability.

Another key adaptation approach is to aggressively increase water use efficiency. Implementing this approach will require the adoption of urban best management practices and other measures. Agricultural entities will be encouraged to apply Efficient Water Management Practices (EWMPs) to reduce water demand and improve the quality of drainage and return flows. In regions where recycled water may represent a relatively energy efficient and drought-proof water management strategy, local water agencies will be encouraged to adopt policies that promote the use of recycled water for appropriate, cost-effective uses while still protecting public health. However, not all water use efficiency activities are equally effective responses to climate change. For example, efficiencies that reduce evaporative (e.g., landscape and crop evapotranspiration), other consumptive uses, and flows to saline sinks (e.g., the ocean) are the most effective.

Statewide, adaptation strategies aim to fundamentally improve water and flood management systems and enhance and sustain ecosystems. Reliable water supplies and resilient flood protection depend upon ecosystem sustainability. Building adaptive capacity for both public safety and ecosystems requires that water and flood management projects maintain and enhance biological diversity and natural ecosystem processes. Water supply and flood management systems are significantly more sustainable and economical over time when they preserve, enhance and restore ecosystem functions, thereby creating integrated systems that suffer less damage from, and recover more quickly after, severe natural disruptions. By reducing existing, non-climate stressors on the environment, ecosystems will have more capacity to adapt to new stressors and uncertainties brought by climate change. Flood management will be improved by increased coordination among existing water and flood management systems. Ecosystem enhancement will include actions to restore previous connections between rivers and their historical floodplains, creating seasonal aquatic habitats and facilitating the growth of native riparian forests.

A strategy for improving management and decision-making capacity focuses on planning for and adapting to sea-level rise. This will require the establishment of an interim range of sea-level rise projections for short-term planning purposes for local, regional, and statewide projects and activities. A scientific panel of the National Research Council (NRC) will provide expert guidance regarding official long-range sea-level rise estimates and their application to specific California planning issues. The DWR, in collaboration with other state agencies and under guidance from the NRC, will develop long-range sea-level rise scenarios and response strategies for the *California Water Plan Update 2013.*

As climate change continues to unfold in the coming decades, institutions, along with infrastructure, may need to also adapt, which may require reconsidering existing agency missions, policies, regulations, and other responsibilities, as well as changes to existing resources legislation. The California Water Plan Update is one example of where such adaptation has already occurred.

Adaptation Strategies and Actions

Climate change is already affecting California's water resources as evidenced by changes in snowpack, river flows and sea levels. Impacts and vulnerability will vary by region, as will the resources available to respond to climate change, necessitating regional solutions to adaptation rather than an easily administered but comparably ineffective "one-size-fits-all" approaches. An array of adaptive water management strategies must be implemented to better address the risks and uncertainties of changing climate patterns. Fortunately, as one water stakeholder has observed, California has far more knowledge, expertise, and financial capacity to adapt its water management systems to climate change than our society had in the 1850's, when an east-coast American society abruptly found itself in a Mediterranean climate upon settlement in the West. The strategies listed below are from *Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water* and the California Water Plan Update; they are cross-referenced with other sectors for contextual efficacy:[21]

Strategy 1: Provide Sustainable Funding for Statewide and Integrated Regional Water Management

<u>Long-Term Actions:</u>

a. **Financing Mechanisms –** A formal assessment of state and local financing mechanisms should be conducted by the state Legislature in order to provide a continuous and stable source of revenue to sustain proposed climate resiliency programs. Activities include regional water planning, inspection, maintenance, repair, and rehabilitation of flood management facilities, observational networks and water-related climate change adaptation research.

Strategy 2: Fully Develop the Potential of Integrated Regional Water Management

<u>Near-Term Actions:</u>

a. **Integrated Water Management Plans (IRWM) –** By 2011, all IRWM plans should identify strategies that can improve the coordination of local groundwater storage and banking with local surface storage along with other water supplies including recycled municipal water, surface runoff, flood flows, urban runoff, storm water, imported water, water transfers and desalinated groundwater and seawater.

b. **Adaptation Component –** By 2011, all IRWM plans should include specific elements for climate change adaptation.

Strategy 3: Aggressively Increase Water Use Efficiency

<u>Near-Term Actions:</u>

a. **Statewide Reduction in Water Use –** As directed by Governor Schwarzenegger, Department of Water Resources (DWR) in collaboration with the Water Boards, the California Energy Commission, the California Public Utilities Commission, the California Department of Public Health (CDPH), and other agencies will implement strategies to achieve a statewide 20 percent reduction in per capita water use by 2020.

b. **Water Efficiency –** Agricultural entities should apply all feasible Efficient Water Management Practices (EWMPs) to reduce water demand and improve the quality of drainage and return flows, and report on implementation in their water management plans.

c. **Energy Efficiency –** Recycled water is a drought-proof water management strategy that may also be an energy efficient option in some regions.

d. **Water Conservation –** The State Water Resources Control Board (SWRCB) and the California Public Utilities Commission may impose water conservation measures in permitting and other proceedings to ensure water conservation efforts. It is recommended that the Legislature authorize and fund new incentive-based programs to promote the mainstream adoption of aggressive water conservation by urban and agricultural water systems and their users.

Strategy 4: Practice and Promote Integrated Flood Management

<u>Near-Term Actions:</u>

a. **Flood Management Improvements –** To reduce flood peaks, reduce sedimentation, temporarily store floodwaters, recharge aquifers and restore environmental flows, flood management should be integrated with watershed management on open space, agricultural, wildlife areas, and other low-density lands.

b. **System Reoperation Task Force –** The improved performance of existing water infrastructure cannot be achieved by any single agency, and will require the explicit cooperation of many. Moreover, system-wide operational coordination and cooperation must be streamlined to respond to extreme events that may result from climate change. Successful system re-operation will also require that the benefits of such actions are evident to federal and local partners. To achieve these goals, the State will establish a System Re-operation

Task Force comprised of state personnel, federal agency representatives, and appropriate stakeholders.

c. **Support Decision Making –** To successfully meet the challenges posed by climate change, the federal-state Joint Operations Center (JOC) capacity should be expanded to improve tools and observations that better support decision-making for individual events, seasonal and inter-annual operations and water transfers. The JOC should be enhanced to further improve communications and coordination during emergencies such as floods and droughts.

d. **Central Valley Flood Protection Plan –** By January 1, 2012, DWR will collaboratively develop a Central Valley Flood Protection Plan that includes actions to improve integrated flood management and consider the potential impacts of climate change.

e. **Emergency Flood Preparedness –** All at-risk communities should develop, adopt, practice and regularly evaluate formal flood emergency preparedness, response, evacuation and recovery plans.

f. **Land Use Policies –** Local governments should implement land use policies that decrease flood risk.

Strategy 5: Enhance and Sustain Ecosystems

<u>Long-Term and Near-Term Actions:</u>

a. **Species Migration and Movement Corridors –** Water management systems should protect and reestablish contiguous habitat and migration and movement corridors for plant and animal species related to rivers and riparian or wetland ecosystems. IRWM and regional flood management plans should incorporate corridor connectivity and restoration of native aquatic and terrestrial habitats to support increased biodiversity and resilience for adapting to a changing climate.

b. **Floodplain Corridors –** Flood management systems should seek to reestablish natural hydrologic connectivity between rivers and their historic floodplains. Setback levees and bypasses help to retain and slowly release floodwater, facilitate groundwater recharge, provide seasonal aquatic habitat, support corridors of native riparian forests and create shaded riverine and terrestrial habitats. Carbon sequestration within large, vegetated floodplain corridors may also assist the state in meeting GHG emissions reductions mandated by AB 32.

c. **Anadromous Fish –** The state should work with dam owners and operators, federal resource management agencies, and other stakeholders to evaluate opportunities to introduce or reintroduce anadromous fish to upper watersheds. Reestablishing anadromous fish, such as salmon, upstream of dams may provide flexibility in providing cold water conditions downstream, and thereby help inform system reoperation. Candidate watersheds should have sufficient habitat to support spawning and rearing of self-sustaining populations.

d. **Tidal Wetlands as Buffers –** The state should identify and strategically prioritize for protection lands at the boundaries of the San Francisco Bay and Sacramento-San Joaquin Delta that will provide the habitat range for tidal wetlands to adapt to sea-level rise. Such lands help maintain estuarine ecosystem functions and create natural land features that act as storm buffers, protecting people and property from flood damages related to sea-level rise and storm surges.

e. **Reversal of Delta Island Subsidence –** The state should prioritize and expand Delta island subsidence reversal and land accretion projects to create equilibrium between land and estuary elevations along select Delta fringes and islands. Sediment-soil accretion is a cost-effective, natural process that can help sustain the Delta ecosystem and protect Delta communities from inundation.

f. **Upper Watershed Services –** The state should consider actions to protect, enhance and restore upper watershed forests and meadow systems that act as natural water and snow storage. This measure not only improves water supply reliability and protects water quality, but also safeguards significant high elevation habitats and migratory corridors.

Strategy 6: Expand Water Storage and Conjunctive Management of Surface and Groundwater Resources

Near-Term Actions:

a. **Expand Water Storage –** California should expand its available water storage for both surface and groundwater supplies.

b. **Surface Storage Feasibility Studies –** DWR will incorporate climate change considerations as it works with the U.S. Bureau of Reclamation (Reclamation) and local agencies to complete surface storage feasibility studies.

c. **Conjunctive Use Management Plans –** State, federal, and local agencies should develop conjunctive use management plans that integrate floodplain management, groundwater banking and surface storage.

d. **Groundwater Management Plans –** Local agencies will be encouraged to develop and implement AB 3030 Groundwater Management Plans as a fundamental component of their IRWM plans.

e. **Local Ordinances –** Cities and counties will be encouraged to adopt local ordinances that protect the natural functioning of groundwater recharge areas.

Strategy 7: Fix Delta Water Supply, Quality and Ecosystem Conditions

Near-Term Actions:

a. **Delta Adaptation Planning** – The legislature, state agencies, and stakeholders should support the implementation Delta Vision Committee recommendations,[iii] and encourage the incorporation of adaptive responses to climate change in the Bay-Delta Conservation Plan and the Delta Regional Ecosystem Implementation Plan.

b. **Sustainable Delta Goals –** By June 2009, DWR will initiate a coordinated state agency effort to invest in Delta ecosystems, water conveyance improvements, flood protection and community sustainability in order to achieve a sustainable Delta.

[iii] The recommendations of the Delta Vision Committee are available at: http://www.deltavision.ca.gov/DV_Committee/Jan2009/081231_Delta_Vision_Committee_Implementation_Report.pdf

Strategy 8: Preserve, Upgrade and Increase Monitoring, Data Analysis and Management

<u>Long-Term Actions:</u>

a. **Climate Monitoring –** Critical for the projection of future water supply, climate change detection and consistent monitoring of critical variables such as temperature, precipitation, evapotranspiration, wind, snow level, vegetative cover, soil moisture and stream flow will be expanded at high elevations and wilderness areas to observe and track changes in the rain and snow transition zone.

b. **Atmospheric Observations –** To better project future rain and snow patterns on a regional scale, atmospheric observations are needed to define and understand the mechanisms underlying atmospheric processes that lead to California's seasonal and geographic distribution of precipitation.

c. **Water Use Feasibility Study –** The accurate measurement of water use can facilitate better water planning and management. By 2009, DWR, the state and regional Water Boards, the Department of Public Health, and the California Bay-Delta Authority will complete a feasibility study for a water use measurement database and reporting system.

Strategy 9: Plan for and Adapt to Sea-Level Rise

<u>Long-Term Actions:</u>

a. **Sea-Level Rise Projections –** The state will establish an interim range of sea-level rise projections for short-term planning purposes for local, regional and statewide projects and activities.

b. **National Research Council study –**The Resources Agency, in coordination with DWR and other state agencies will convene and support a scientific panel from the National Research Council (NRC) to provide expert guidance regarding long-range sea-level rise estimates and their application to specific California planning issues.

c. **California Water Plan Update –** Based upon guidance from the NRC, DWR, in collaboration with other state agencies will develop long-range sea-level rise scenarios and response strategies to be included in the California Water Plan Update 2013.

Strategy 10: Identify and Fund Focused Climate Change Impacts and Adaptation Research and Analysis

<u>Long-Term Actions:</u>

a. **Research Planning and Partnerships –** In association with research institutions such as the Regional Integrated Sciences and Assessment centers, Lawrence Livermore and Berkeley National Laboratories, and the University of California, state agencies will identify research needs that provide guidance on activities to reduce California's vulnerability to climate change. The state will also explore partnerships with the federal government, other western states, and research institutions on climate change adaptation.

b. **Sensitivity Analysis –** The state's water supply and flood management agencies will perform a sensitivity analysis of preliminary planning studies, along with risk-based analyses for more advanced planning studies. For flooding, sensitivity and risk-based analyses an appropriate risk tolerance and planning horizon for each individual situation is under consideration. Selection of climate change scenarios for these analyses can be guided by recommendations of the Governor's Climate Action Team.

c. **Pilot Projects –** The sponsorship of science-based pilot projects for watershed adaptation research is needed to address climate change adaptation for water management and ecosystems. Funding for pilot projects should only be granted in those regions that have adopted IRWM plans that meet DWR's plan standards and have broad stakeholder support.

d. **California Water Plan Update –** Every five years DWR will provide revised estimates of changes to sea level, droughts, and flooding that can be expected over the following 25 years, this will be included in future versions of the California Water Plan Update.

VIII. AGRICULTURE

Introduction

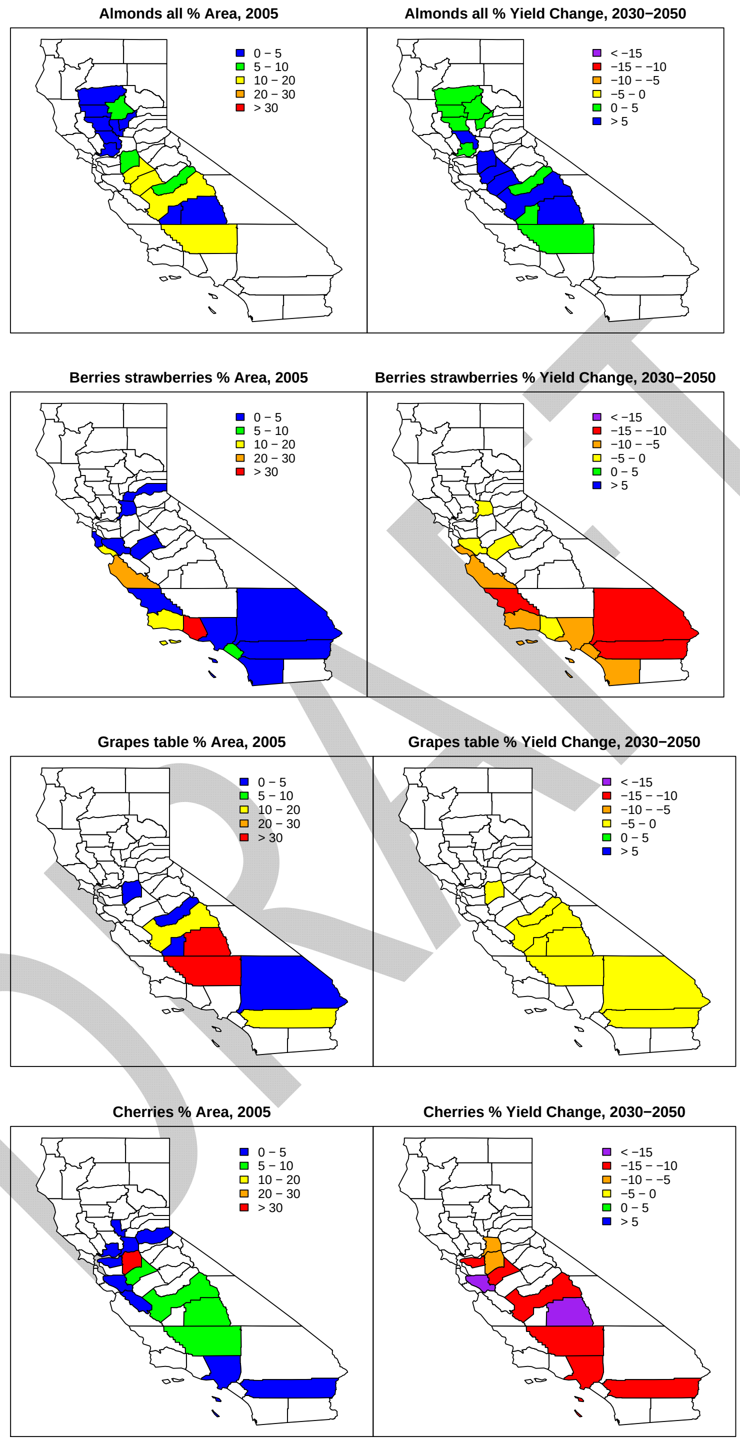
"Conservation is ethically sound. It is rooted in our love of the land, our respect for the rights of others, and our devotion to the rule of law." -Lyndon Baines Johnson

California has been the most productive agricultural state in the union for more than 50 years.[1] From 1974 to 2004, the value of California's agricultural commodity gross cash receipts more than quadrupled while the total acreage devoted to agriculture declined by 15 percent. This growth in production gross sales value is due largely to technological improvements in crop production and more intensive use of farmland, including the shift to higher value crops. Today, with 88,000 farms and ranches, California agriculture is a $37 billion a year industry.[2] California has become the nation's leading producer of nearly 80 different crop and livestock commodities. In fact, the state supplies more than half of all domestic fruit and vegetables and is responsible for more than 90 percent of the nation's production of almonds, apricots, raisin grapes, olives, pistachios and walnuts.

The diversity and size of California's agricultural sector creates unique opportunities and challenges with regard to climate change. Climate change alters both average and extreme temperatures and precipitation patterns, which in turn influence crop yields, pest and weed ranges and introduction, and the length of the growing season. Extreme events, such as heat waves, floods, and droughts, may be among the most challenging impacts of climate change for agriculture since they can lead to large losses in crop yields and livestock productivity. Since California plays a critical role in feeding not only state residents, but those of the U.S. and other countries, these large production declines and losses would translate to not only food shortages but financial and economic shifts that could disrupt local, regional, and national commodities systems. In the Delta region, saltwater intrusion from sea level rise may make production of certain crops increasingly challenging. Traditional water delivery systems may face challenges due to generally drier conditions and the reduction of the Sierra snowpack concurrent with urban demand increases.

Understanding the implications of climate change on the agricultural sector not only underscores the importance of California's leadership in reducing GHG emissions, but can also provide invaluable guidance to growers and policymakers on how to prepare for and adapt to changes that may occur.

Figure 17: California Perennial Crops in a Changing Climate



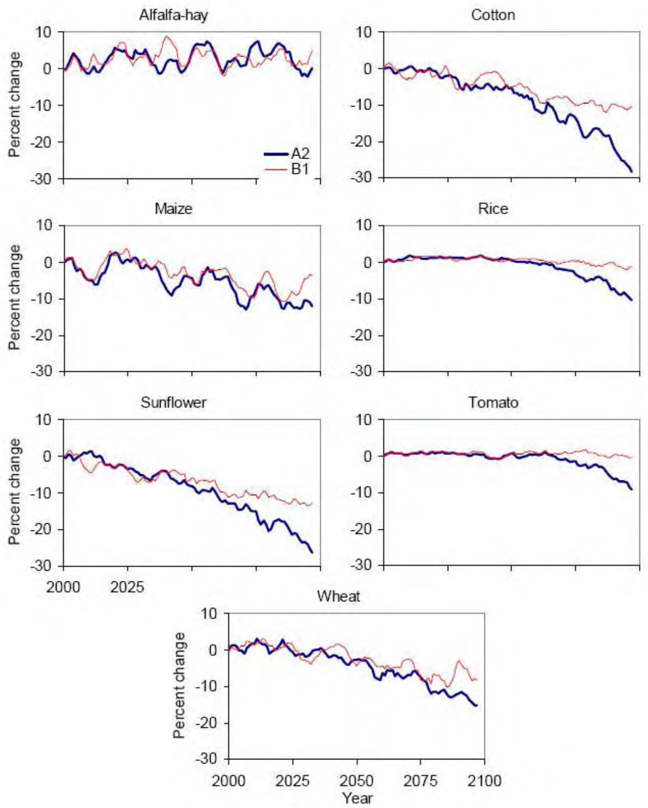
Current % of crop area in each county (left) and average projected changes in county yields (right) for four perennial crops. Yield changes are expressed as percentage difference between average yields in 2030–2050 and those in 1995–2005

Future Climate Change Impacts to Agriculture

A. Increased Temperature and Extreme Events

California's agriculture could be severely affected by the warming projected by the latest climate change models.[3] Some crop yields may increase with warming, while others may decrease. According to these models, many of today's top annual field crops such as wheat, cotton, maize, sunflower, and rice show declining yields later in the century due to rising temperatures (see Figure 18).[4]

Figure 18: *Modeled Crop Yields by 2100, Shown in 25 Year Increments (2000, 2025, 2050, 2075, 2100)*



Conversely, the production of high-quality wine grapes is expected to benefit from a warmer climate because of a longer growing season and more favorable growing conditions in the short-term. At some point, however, the magnitude of the warming may become too large for certain grape varieties.

Agriculture may benefit from higher levels of atmospheric CO_2 (which functions as a fertilizer and increases the efficiency of the plants' water use) as well as from the lengthening of the growing season as freezing temperatures may become less common over the course of the 21st century. Yet these temperature changes not only affect desirable crops, but also undesirable pests. Weeds and other invasive species are likely to migrate north due to temperature increases, while disease and pest pressures will increase with earlier spring arrival and warmer winters. In addition, crop-pollinator timing can also be affected by climate change, leading to a need for modifications in crop production.

Higher average temperatures can cause increases in mortality and/or decreases in productivity of livestock, leading to decreases in meat, egg, and dairy production and reproductive success of cattle.[5] Greater proliferation and survival of pathogens and pests will affect both crops and livestock.[6]

PREDICTED AGRICULTURAL IMPACTS OF WARMING

- Crop Yield Changes
- Changes in Crop Types and Cultivars
- New Weed Invasions/Expanded Ranges of Existing Weeds
- New Disease & Pest Invasions/Expanded Ranges of Existing Diseases & Pests
- Flooding and Crop Pollination Changes
- Heat Waves and Stress
  - Loss of Crop Quality and Yields
  - Increased Vulnerability to Pests
  - Increased Animal Vulnerability to Disease
  - Increased Mortality of Animals
  - Less Production from Animals

Temperature and precipitation changes can also disrupt the critical link between agriculture and biodiversity. In California a large number of wildlife species are dependent on privately owned agricultural lands for habitat. As temperature and precipitation patterns change it is likely that there will be a shift in the intensity and location of agriculture that could impact fish and wildlife resources. Agricultural lands can provide significant habitat and connectivity between protected reserves, but can also compete with fish and wildlife for resources that may become limited due to climate change. Predictions of higher proportion of precipitation in the form of rain with concomitant loss of snow pack suggests more frequent summer droughts, thereby creating conflicts between beneficial uses of water. Further impact to fish and wildlife may result from the management of pests and pathogens that may proliferate within agricultural settings with warming temperatures.

Reduction of Chill Hours

While many crops benefit from the increase in average temperatures and the lengthening of the growing season, not all do. Some of California's most valuable crops, such as fruits and nuts, require a certain number of chill hours in the winter. Chill hours are the number of hours below a certain temperature that a plant requires for dormancy before springtime growth. The temperature threshold and duration of dormancy needed are species-dependent, yet without the required period in dormancy, blooming, the setting of fruit, fruit quality, and therefore crop yields are negatively affected.[7]

The number of winter chill hours has already declined since 1950 with the greatest rates of change occurring in the Bay Delta region and the mid-Sacramento Valley. Grapes and almonds, which are grown in these regions, may need to be replaced with new cultivars that require fewer chill hours or alternative crops that do not require as many winter chill hours in order to avoid substantial losses.

For many high-value crops, a reduction of chill hours could be harmful. In one study, researchers examined the effects of climate change on the 20 most valuable perennial crops grown in California. They found that cherries, the 18th most valuable perennial crop in the state, are likely to be the most negatively affected by warming in coming decades. This finding is likely related to a loss of chilling hours. A second robust finding of the study was that almonds, the most valuable perennial crop in California, will be harmed by increasing February temperatures. None of the crops studied showed any clear benefits from projected warming.[8]

Changing Temperature Extremes

Understanding how climate change affects the occurrence of temperature extremes is crucial for California's agriculture. The costliest extreme event to California's agriculture in recent years was the freeze of December 1998. Various crops, including oranges, lemons, olives and cotton, experienced major losses. The second costliest individual extreme event was the heat wave of July 2006, which was especially damaging to the livestock industry.[9] Such events are predicted to be more common with climate change.

In recent decades, cold extremes have already become less frequent, and are projected to become even less frequent across the state in the future.[10] Heat waves, by contrast, are very likely to become more frequent due to climate change.[11,12] Climate scenarios using the higher emissions scenario suggest that heat waves similar in length and intensity to the one experienced in July 2006 may become as frequent as once a year in many parts of California by the end of the century.[13]

The heat stress caused by extremely high temperatures can increase livestock vulnerability to disease, infection, and mortality; and can decrease livestock production. For crops, heat stress can lead to losses in quality and yields; and can increase plant vulnerability to pests. Extreme heat can also indirectly affect irrigated agriculture by generating short-term disruptions of the water supply, as well as increased water needs due to higher rates of water loss from plant evapotranspiration.[14]

B. Precipitation Changes and Extreme Events

Most climate change projections show a general drying trend over California, resulting in reduced water deliveries from a decreasing Sierra Nevada snowpack. This would lead to a water supply and supply reliability risk for agriculture, with more competition among all water users. A decrease in water supply reliability will direct crop selection to crops, such as row/field crops, that are not dependent on a steady long-term supply of water. Also, with less reliability, comes greater risk, which affects the availability of operating credit from lending institutions. One study found that under any projected climate scenario, agriculture would consistently be most vulnerable to water shortages. Researchers also estimated that annual costs of approximately $200 million would be incurred by agriculture if water availability was more than 20 percent lower than demand. [15]

Droughts and legal constraints on water delivery have in some years led to losses in excess of $1 billion annually to Central Valley agriculture, translating to tens of thousands of lost jobs. Thus, short of significant adaptations, water supply reductions will adversely affect agricultural crop yields. One modeling study combining future crop yield predictions with future water supply stresses indicated notable declines in overall crop acreage and production by 2050.[16]

Non-irrigated lands, despite their lack of dependence on water delivery systems, can also be impacted by altered precipitation patterns.[205] For example, low rainfall results in less forage on California rangelands, which can result in lower livestock productivity and increased soil erosion and water quality degradation.

Agricultural impacts can differ geographically under Delta water system shortages. For example, water shortages may be more acutely felt in the western San Joaquin Valley and Tulare Basin.[17] The San Joaquin Valley is projected to have potentially greater irrigation demands and evapotranspiration than the Sacramento Valley, leading to more risk for agriculture in the southern Central Valley counties by the end of the century.[18] Some of these shortages may be managed by changes in technology and agricultural practices. For example, if additional water conservation measures and new technology becomes available in the next few decades in San Diego County, agricultural demand for water could actually decrease, shrinking from 13 percent of total county demand in 2005 to six percent in 2030.[19]

Drought can produce severe lack of water for crops and livestock, increase the risk of fire on rangeland, and ultimately reduce food security. Historically, irrigation has helped to minimize the impact of droughts, but climate projections suggest that long-lasting droughts may become more common under the higher emissions scenario later in the 21st century. Such severe decreases in water availability may well limit the types and amounts of crops grown in California.[20]

Agriculture- Predicted Impacts of Precipitation Changes

- Loss of Water Supply and Reliability
- Loss of Food Security as Water Supply Diminishes, is Less Reliable
- Loss of Irrigated Lands, Crop Production and Food Security
- Lack of Water for Agriculture and Livestock
- Drier Conditions May Affect Agricultural Crop Yields
- Increased Fire Risk to Rangeland
- Dry Steep Terrain - Increased soil erosion and sedimentation from Agricultural Lands
- Changes in Pests, Diseases and Invasive Species
- Changes in ozone and air quality - likely adverse affects on crop production

The ultimate impact of changing water supplies will depend on the degree to which farmers switch to crops and livestock that are better adapted to the new climate conditions as well as to potentially lower water supplies, market value changes in crops and livestock, and usage of water efficiency and conservation measures. According to DWR, most new water that derives from conservation will come from urban water use efficiency; most readily-adopted agricultural water conservation measures have already been implemented.[21] The gains in water use efficiency by agriculture over the past forty years was documented in a recent preliminary draft paper, which documented a doubling in inflation-adjusted dollars of agricultural gross revenue between 1967 and 2007, while during the same period total crop applied water fell by 14 percent.[22]

Heavy Rainfall and Flooding Events

AGRICULTURE IMPACTS OF SEA LEVEL RISE

- Saltwater Intrusion onto Coastal Farmland Soils
- Seawater Flooding of Low-lying Farmland
- Increases in Soil, Surface Water, and Ground Water Salinity
- Increased Upstream Flooding

The agricultural sector is also challenged in wet conditions. For example, some farmlands in or near floodplains could be inundated when winter and spring rainfall combine with rapid snow melt (due to higher temperatures over the Sierras) and generate larger runoff than streams and soils can absorb.[23]

Flooding during the planting season is known to be particularly damaging for crops. A study of the impacts of extreme events on California agriculture, using disaster and insurance loss data over the years 1993-2007, showed that excess moisture related to heavy rainfall events and subsequent flooding led to the greatest overall economic losses during these years.[24] Specifically, heavy rainfall in the spring and winter months accounted for the 3rd, 4th and 5th costliest individual extreme events. While the number of storms is not expected to increase in the future, heavy rainfall events will continue to play a significant role in California's future climate. Especially in the Delta region, increases in winter flooding can be expected due to the coincidence of rainfall events and earlier runoff with higher sea levels. This may necessitate additional levee maintenance to protect farmland.

C. Sea Level Rise

Sea level rise impacts include saltwater intrusion onto farmlands and an increased risk of coastal flooding of low-land agriculture. Both will raise soil salinity to a point which most crops currently grown are not adapted. Increases in surface and groundwater salinity, as well as decreases in irrigation water quality near the coast, will negatively impact coastal agriculture.

Sea level rise impacts may also constrain farmers' abilities to adapt to changing water supplies and temperatures as some management practices, irrigation methods, and crop switching may not be possible in areas near sea level increases. Livestock operations and croplands may need to be relocated onto more productive lands. Investments in technology, plant breeding and cropping system research will help minimize some of the projected climate change-related agricultural impacts.[25]

D. Risks for Agriculture

To summarize the changing risks that California's agricultural sector may be facing from climate change, the likelihood of occurrence of the projected consequences was qualitatively assessed. The emerging risk profile for the agricultural sector can be characterized as follows:

- Climate change is likely to alter precipitation amounts and patterns, average as well as maximums and minimum temperatures, pest and weed ranges, the length of the growing season, sea level, and other factors. The resulting critical changes in water availability, temperatures, sea level rise and extreme events will all affect crop and livestock productivity.

- Extreme events may be among the greatest challenges, as they can lead to large losses of crops, impose stress on livestock, and be most difficult to manage.
- Perennial crops such as grapes, fruits, and nuts will experience varying risks, with moderate warming potentially benefiting some crops such as table grapes and almonds, but mostly negatively impacting other perennial crops, such as cherries.
- Yields of some annual crops such as cotton, maize, sunflower, and wheat are expected to slightly decrease by mid-century, while rice and tomato yields remain more or less unchanged. By the end of the century there is a growing risk of declining yields of all examined crops except alfalfa; that risk is significantly higher under the higher emissions scenario.
- Livestock is particularly at risk from heat extremes, which can lead to increased risk of mortality, lower productivity, and lower reproductive success.
- Sea level rise and increased winter run-off together with meltwater will increase low-land flooding risks. Sea level rise together with higher moisture loss from soil and water table drawdown will increase the risk of high salinity in coastal soils, thereby negatively impacting salt-sensitive crops.
- Disruptions in temperature and precipitation patterns can disrupt the link between agriculture and biodiversity.

Agriculture Adaptation Strategies

Introduction

The state agencies that participated in the Climate Adaptation Working Groups (California Department of Food and Agriculture and California Department of Conservation) developed the following strategies and shall be responsible for and will spearhead strategy implementation. California's agricultural sector plays a large role in the state's economy and rural culture; as a result, climate change will have countless impacts on the cultivation of crops and livestock. California agriculture has been successful in large part due to its capacity to adapt from year to year and over the long haul to changing growing conditions, such as pests and disease, labor availability, weather and market demands. To adapt to changes in temperature and precipitation, a number of approaches are proposed or in development to assist in increasing the diversity of California's agricultural commodities thereby fostering resilience within the industry. The identification and development of crops and animals found to be resistant or better suited to the myriad of climate change variables is central when planning for adaptation and will ultimately support California farmers and preserve their ongoing operations.

Local Government Example:

Yolo County is completing the update of its general plan. The update places a strong emphasis on responding to climate change, including policies to help agriculture adapt. Among the policies are those that aim to keep as much agricultural land free from the constraints of urbanization, thus broadening the landscape flexibility for adaptation; protect water supplies through such measures as protecting groundwater recharge basins and supporting improvements in water use efficiencies; assist farmers to anticipate and respond to opportunities and adversities resulting from climate change; promote practices that sequester carbon long-term to help growers qualify for carbon credits; support the production and use of agricultural bio-fuels for economic sustainability; and, promote local market outlets to reduce transportation energy costs.

Increased research into development of crops which exhibit an increased tolerance to heat waves, high average temperatures, drought, pests and disease should be encouraged. Strategies are also being developed that support the research of crop rotations that maximize efficient water usage. Improvements in irrigation systems will further the reliability of water supplies through water conservation. Management practices that address adaptive flood control will also serve to benefit existing levees and adjacent floodplains; while incentives will allow for the cultivation of floodplain compatible crops introduced in the areas prone to regular flooding.

To protect against agricultural weeds, pests and diseases, additional investments should be made in the detection, prevention and eradication of invasive species that originate from outside of the state or have relocated from other regions within the state. Further research is needed in the development of best management practices that enable adaptation, or can help predict and respond to the spreading of weeds, pests, and disease. Resilience to harmful pests and associated diseases may be optimized by providing growers with the most favorable management techniques possible, ones that will sustain planting, thinning, and harvest timing.

In concert with adaptation, mitigation protocols favor low carbon emission strategies such as renewable energy production on farms, and the development of a carbon and carbon equivalent credit mechanism that can facilitate the sustainability of California farming in the future. Research is also needed to develop low-carbon, non-petroleum crop protection tools.

Agriculture is part of the existing environment and to ensure that agriculture has room to adapt to a warming climate by moving onto lands in cooler climate further north or in higher altitudes, local general plans will need to zone for and protect such lands for future agricultural growth. Incorporating climate change model results in general plan updates that recognize the value of these lands will need to be encouraged through strategies that provide information as well as incentives to local governments.

Adaptation Strategies and Actions:

California's agricultural sector plays a large role in the state's economy and culture and is thus vital to sustain. To adapt to the expected changes described earlier in this chapter, the sector has a wide range of options. Those which are consistent with the activities of DOC (Department of Conservation) and CDFA (California Department of Food and Agriculture) include, but are not limited to the following:

Strategy 1 – Promote Agrobiodiversity

<u>Near Term Actions</u>:

a. **Technical Assistance and Outreach** - Use new and existing technical and financial assistance programs, and informational outreach to increase the diversification of the agricultural landscape. For example, hedgerows, riparian restoration and wetlands can provide grower opportunities for diversification of income from carbon sequestration and other environmental services credits; create opportunities for pest predator and pollinator habitat; and enhance resilience against climate change.

b. **Bio-Energy** – The University of California Cooperative Extension (UCCE), along with the California Energy Commission (Energy Commission) and the California Department of Food and Agriculture (CDFA) should encourage the development of sustainable agricultural feedstocks for bio-energy that use marginal land and avoid competing with both plant and animal food production.

c. **Livestock/Rangeland Best Management Practices** – State agencies should support economically viable best management practices that reduce heat stress on livestock, such as water-cooling, increased shade canopy (e.g., increased planting of trees for shade on rangeland to facilitate carbon capture and sequestration) and the improvement of diets and breeds for heat tolerance and to maximize weight gain.

Long Term Actions:

d. **Climate Resistant Crops** - Support identification, research and development of crop varieties and cultivars capable of adapting to expected climate change (e.g. with respect to changes in temperature, precipitation, pest and disease resistance, air quality and drought tolerance) in order to assist growers in the selection of crop and livestock most likely to succeed.

e. **Crop Diversification** – The University of California, in partnership with the Energy Commission and the CDFA should support the identification, agronomic and economic analysis of second-generation (cellulosic) energy crops for use by growers to diversify their production options, improve their ability to adapt to climate change, and create long-term opportunities for recycled water reuse.

f. **Cultural/Economic Diversification** – The University of California, in partnership with the Energy Commission and the CDFA will support the identification, agronomic and economic analysis of evolving markets, organic systems, ecotourism, new types of markets, or improved transportation of commodities to markets.

Strategy 2 - Farm and Land Management

Near Term Actions:

a. **Permit Streamlining** – The State Environmental Protection Agency (CalEPA) and CDFA will promote and facilitate permit streamlining coordination of dairy digester technologies. Provide technical and financial assistance for these regional and on-farm sources of renewable, low carbon energy, and encourage the economic and environmental sustainability of California dairies and rural lands.

Long Term Actions:

b. **Sustainable Product Development** – California Department of Food and Agriculture and the University of California Cooperative Extension should support new and existing markets for sustainable agricultural products that will support agronomic practices that increase both the use of renewable inputs and the carbon content of agricultural soils.

c. **Technical Assistance & Funding** - Complement federal financial and technical assistance programs for farmers under the leadership of the Department of Conservation (DOC) to collaboratively encourage improved farm management practices involving tillage, rotations, manure management, fallowing, use of cover crops, and fertilizer-use efficiency, which result in net environmental benefits including reduction of soil erosion, increased soil fertility, water-holding capacity, and reduced on and off-site contamination of water resources.

d. **Grower Outreach** – State agencies should provide information on the benefits of crop management (e.g., manipulation of planting, thinning and harvesting dates) in order to adapt to climate change impacts resulting in the increase of crop pests and disease, as well as increases in temperature and changes in precipitation.

e. **High-Carbon Crop Cultivation** – State agencies should incentivize the use of crop options, encourage economic sustainability and the development of carbon credit protocols for the cultivation of *high-carbon* annual crops and woody plants in appropriate natural areas (e.g., riparian forests, hedgerows and windbreaks.) Relevant state agencies, including DFG

(Department of Fish and Game), should be consulted on certain technical issues related to energy crop cultivation.

f. **Research** – State agencies should invest in research and development to determine nitrous oxide generation from soil, irrigation, carbon and nitrogen input. Identify peer-reviewed scientific methodologies on an industry-wide basis that will reduce greenhouse gases. Develop protocols where appropriate and feasible that provide incentives to growers (e.g., GHG credits) to improve fertilizer and manure crop delivery technology.

Strategy 3 - Water Supply and Conservation

<u>Near Term Actions:</u>

a. **Improve Water Quality Compliance** – Support regional water board efforts to streamline regulatory compliance when it furthers the goals of climate change adaptation and mitigation (e.g., the State Water Resources Control Board's Irrigated Lands Regulatory Program and Central Valley Regional Water Quality Control Board's General Waste Discharge Order for existing dairies). Collaborate with agricultural stakeholders to develop best management practices that encourage and support profitable farming systems; and when possible develop collaborative water quality partnerships and programs that can be co-funded by beneficiaries.

b. **Water Conservation** - Continue to exchange water conservation activities at the farm and district level by initiating incentives, distributing information and introducing other strategies that encourage the development of diverse farm and irrigation district water sources.

   i. **California Irrigation Management Information System** - Expand the collection and dissemination of local weather information for irrigation planning and expand the California Irrigation Management Information System (CIMIS).

   ii. **Mobile Irrigation Labs** - Encourage the revitalization of the Mobile Irrigation lab program with the assistance of the Water and Resource Conservation Districts.

   iii. **California Agricultural Water Management -** Support expansion and development of voluntary district-level water conservation plans for all agricultural water districts; and encourage the implementation of approved district conservation plan actions (e.g., tailwater return ponds).

   iv. **Collaboration & Partnerships** - DOC will collaborate with the USDA Natural Resources Conservation Service to prioritize and expand technical and financial cost-share assistance programs (e.g., farm conservation planning, water use efficiency, micro-irrigation, low energy precision application drip systems, and land-leveling) for growers.

   v. **Energy Efficient Water Recycling -** Invest in new uses for saline drainage water, using renewable solar and on-farm bio-fuels energy sources to treat saline water. This is partially mitigation, but should focus on re-use of saline drainage to expand supplies through treatment.

   vi. **Water Pricing Incentives** – Incentivize water pricing systems that reward conservation, accounting for regional differences in growing conditions, crops, and other agronomic needs.

   vii. **Urban Conservation Programs -** Invest in urban water conservation programs that result in increased local sources of agricultural irrigation water available for future use.

   viii. **Water and energy use efficiency on farms -** DOC shall implement statewide expansion of the Watershed programs which support adaptive management through watershed stewardship and project implementation grant awards, including practices that increase water and energy use efficiency on farms.

c. **Floodplain Easements -** Work with willing sellers to identify voluntary floodplain corridor protection (flowage) easements on agricultural lands to maintain agricultural production that is compatible with flood conveyance. These actions will also enhance economic sustainability and protect urban residents from flooding, while protecting agricultural lands for the continued production of food and fiber.

Long Term Actions:

d. **Drought Tolerant Research -** Support research and development for more drought-tolerant cultivars and crop rotations.

e. **Improve Water Reliability -** Initiate reliability of irrigation water delivery to facilitate farm and district-scale crop and farm management to better adapt to climate change.

   i. **Water Projects** - Continue to improve the coordination of the State Water Project, Central Valley Project, and Colorado River Project operation.

   ii. **Water Conveyance** - Improve state and regional water conveyance systems to move more wet-year flows to off-stream and groundwater storage and to facilitate intra-regional water transfers.

   iii. **Increase Storage Capacity** - Expand and improve the use of existing surface and groundwater storage capacity while developing new surface and groundwater storage.

   iv. **Integrated Regional Water Management Planning** - Increase regional reliance of water supplies through continued support for integrated regional water management planning.

   v. **Increase Recycled Water Use** - Consistent with state policy, supplement existing agricultural water supplies by encouraging the increased agricultural use of recycled urban water.

f. **Flood Response** - Initiate actions to reduce the harmful effects on agricultural lands from increased flooding likely from more intense storms and sea level rise.

   i. **Levee Improvements** - Improve levees to protect the state's most productive farmland and reduce damage to investments, such as agricultural infrastructure and irrigation systems (e.g., land leveling and irrigation ditches, etc)

g. **Develop Severe Drought Response Strategies** – Support research and development of emergency response plans for agriculture in severe drought.

Strategy 4 - Agricultural Invaders, Pests, and Diseases

The California Invasive Species Council (CISC) will coordinate invasive species response for the State. The CISC mission is to provide policy level direction and planning for mitigating harmful invasive species infestations throughout the state and for preventing the introduction of others that may be potentially harmful; and to foster coordinated, streamlined approaches that support initiatives for the prevention and control of invasive species, avoiding program duplication by building upon the core competencies of member organizations. The CISC is chaired by CDFA Secretary Kawamura and vice-chaired by CNRA Secretary Mike Chrisman. Also serving on the council will be Secretary Linda Adams of California's Environmental Protection Agency; Secretary Dale Bonner from the Business, Transportation and Housing Agency; Secretary Kim Belshe from the California Health and Human Services Agency; and Matt Bettenhausen, Acting Secretary of the California Emergency Management Agency.

Near Term Actions:

a. **Inspection Stations** – Increase vigilance at the state's port-of-entry inspection stations to prevent entry of new diseases, pests and weeds.

b. **Statewide Detection** - Increase the effectiveness of statewide detection system in order to detect newly introduced pest species.

c. **Agency Coordination** - Improve coordination among agencies to improve detection and eradication of diseases, pests and weeds in targeted areas given ecosystem disturbances.

d. **Warning Systems** - Develop disease warning systems to improve the response to detected infestations.

e. **Pollinator Technical and Financial Assistance** - Provide technical and financial assistance and incentives for the conservation of "bee pastures" and the use of on-farm planting beneficial to pollinators, all with consideration given to crop compatibility (i.e. seedless crop varieties).

f. **Pest Control and Pollinators.** Balance increased pest control measures with the need to maximize pollinators and beneficial insects and microorganisms.

g. **Information Distribution** - Provide information to the agricultural community to enable growers to modify farm management practices and adapt to new pests and diseases.

Long Term Actions:

h. **Prevention and Detection** - Invest in the prevention, detection and eradication of noxious invaders due to climate change that come from outside California, and native California species that move into new regions of California.

   i. **Collaboration and Information Sharing** - Increase interstate and statewide cooperation in the sharing of databases, modeling, detection, warning systems and eradication.

   ii. **Field Experiments** - Initiate field experiments for climate gradients that represent the range of future climates (e.g., landscape surveys) providing data on predictors, potential invasions and expansions of pests, weeds and diseases.

   iii. **Identify Risks** - Identify pests and pathogens that may potentially place California at risk. Conduct analysis of previously developed scenarios from regions with similar climatic conditions.

i. **Sustained Research and Extension** - Invest in research and development of control strategies and chemicals that add to the toolbox of Integrated Pest Management in anticipation of climate change. Distribute research results through University of California Cooperative Extension programs.

   i. **Adaptative Strategies** - Support research into management strategies that assist grower adaptation to increased pest and disease pressures, such as changes in planting, thinning and harvesting timing.

   ii. **Resiliency Development** - Safeguard farm and regional crops and livestock against uncertain pests and disease exposure by developing more resilient cultivars and breeds (i.e., develop more stone fruit varieties with fewer chill hours required for good harvests).

   iii. **Disease and Pest Resistance** – Support research and development on the identification of plant cultivars and livestock breeds that are resistant to predicted disease and pest pressures.

   iv. **Bee Colony Collapse** - Support research on the causes of bee colony collapse and the effects of climate change and adaptation strategies on healthy pollinator populations

v. **Modeling** - Support research on impacts of climate change that improves our understanding through the development of better scientific models on temperature and precipitation patterns to predict the spread of disease, noxious weeds and pests.

Strategy 5 - Land Use

Near Term Actions:

a. **Policy Integration** - CDFA should provide guidance for cities and counties to help develop and adopt sustainable agriculture[iv] policies.

   i. **Adaptable Farmlands** – Encourage the conservation of the most productive and adaptable farmland by supporting smart growth (e.g., urban growth boundaries, in-fill, redirection and redevelopment of existing urban areas)

   ii. **Community Land Use** – CDFA will encourage community land use planning to support sustainable agriculture at the urban interface, helping to give a level of certainty to growers of the future use of their lands for agriculture.

   iii. **Local and Regional Markets** – Encourage and support the development of local and regional markets to reduce vehicle miles traveled in transport of food.

   iv. **Co-Locate Agricultural Industries** - Appropriate state agencies should work with local jurisdictions to promote land use planning that facilitates the co-location of agricultural support industries (i.e., processing, input suppliers and farm labor) in close proximity to farms to reduce the cost of transportation and energy use.

   v. **Protection of Farmland -** Under the leadership of the DOC, ensure the continuation of the Land Conservation Act (1965) and the California Land Conservancy Program, as well as other local and state agency programs to permanently protect farmland. Use the Land Conservation Act in combination with the Farmland Mapping and Monitoring Program and the California Farmland Conservancy Program to identify and secure lands that offer future productivity potential against climate impacts (e.g., lacustrine and alluvial soils at higher elevations, or northern climates.)

   vi. **Mapping Collaboration -** Develop and employ methods to update existing soil classification maps based on climate change scenarios in collaboration with the Natural Resources Conservation Service.

b. **Flood Mitigation** - Protect farmland from flooding impacts and recommend incentive programs to support floodplain compatible agriculture in floodplain corridors.

   i. **Wetland Easements** – Pursuant to DWR Water Plan 2009, continue purchase of wetland easements on marginal, flood-prone, agricultural lands to diversify grower income and buffer productive lands from flood events and improve the environmental services provided by these lands. These efforts may include DWR, DFG, NRCS (Natural Resource Conservation Service), WCB (Wildlife Conservation Board) or other funding sources and incentivize private investment in the establishment and preservation of wetlands.

[iv] Per the 1990 "Farm Bill," sustainable agricultural policies consist of an integrated system of plant and animal production practices having a site-specific application that will, over the long term: satisfy human food and fiber needs; enhance environmental quality and the natural resource base upon which the agricultural economy depends; make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls; sustain the economic viability of farm operations; and enhance the quality of life for farmers and society as a whole.

c. **Reduce Transportation Energy Costs**. Increase the economic sustainability of the agricultural industry by assisting the industry reduce energy costs (and emissions) associated with the movement of agricultural products to markets.

<u>Long Term Actions:</u> The near term actions, as they are comprehensive, are expected to continue long term. Additional long term land use actions for consideration include the following:

d. **Reduce Greenhouse Gas** - CDFA and the Resources Agency will work with the Climate Action Team and the Air Resources Board to identify opportunities to include farm carbon sequestration as an offset credit. Examples include promotion of offset credits for GHG emissions trading that includes the carbon sequestration by soils and other GHG reduction measures, as well as supporting research and development of protocols for agricultural practices that can potentially reduce GHG emissions. CDFA shall have a major role in developing the mechanisms for offset credits.

    i. **Credits and Offsets** - Promote the integration of carbon offset markets with environmental market credits (i.e., water quality and wildlife habitat improvements) to reduce greenhouse gases, and improve the economic and environmental sustainability of agricultural operations.

Strategy 6 - Institutional Support

<u>Near and Long Term Actions:</u>

a. **Build Institutional Capacity** – Initiate the budgeting for, and recruitment and training of staff within the California Department of Food and Agriculture (CDFA) in order to provide long term climate adaptation strategies, particularly with respect to invasive species, agricultural diseases and pests; agrobiodiversity; and, farm and land management.

b. **Information Clearinghouse** - Establish information clearinghouse(s) for growers that provide information and guidance on adaptive management of crops and cultivars, air quality, precipitation, pests and diseases, climate change scenarios, annual planning, disease and pest invasions, control strategies, water conservation technology, technical and financial assistance, crop failure insurance and general information pertinent to climate change adaptation.

Strategy 7 - State-Agency Collaboration

<u>Near and Long Term Actions:</u>

a. **Collaboration** - Maintain statewide collaboration to address climate adaptation issues, policies, joint research and the efficient use of interagency funding mechanisms.

Strategy 8 - Adaptation and Mitigation Coordination

<u>Near and Long Term Actions:</u>

a. The CDFA has identified the following efforts that co-benefit mitigation and adaptation:

    i. **Energy Crop Research** - An Interagency agreement is planned for initiation by the Summer of 2009 between the California Energy Commission and CDFA to undertake field research on potential energy crops that use less energy, water and chemical inputs; and will offer options for adaptable crops while creating new sources of low carbon fuels.

ii. **Renewable Energy -** CDFA is working with the San Joaquin Valley Partnership and the SJV Clean Energy Organization to remove barriers and promote the adoption of clean, farm-based energy technologies such as biogas, biofuels and biomass technologies.

iii. **Impacts Research** - Using federal and state funds, CDFA is currently supporting research to assess the potential impacts of climate change on walnuts; and to explore best management practices that increase the efficiencies and reduce the use of nitrogen fertilizers, thereby maintaining crop yields while reducing the emissions of nitrous oxide.

iv. **Digester Technology -** CDFA is working with stakeholders, researchers and regulators to remove barriers to the installment of digester technology on dairy farms and rural areas; this source of renewable energy will generate revenues, reduce manure disposal and regulatory costs, and help the dairy industry adapt to climate change as its energy costs for measures such as livestock cooling increase.

v. **Invasives Control** – The California Invasive Species Council was recently established, chaired by CDFA Secretary Kawamura and Vice-chaired by Natural Resources Agency Secretary Chrisman. The purpose of the Council is to assist in minimizing the negative effects of non-native species on the state's agricultural and other environments.

IX. FORESTRY

Introduction

Forestlands and rangelands occupy over 80 percent of California's 100 million acres. Forests and woodlands, which cover about 31 million acres, have at least 10 percent tree canopy and include coniferous and hardwood habitats. About half of this area consists of timberland, land capable of growing 20 cubic feet of wood per acre annually. The most recent timber yield data shows that over 1.6 billion board feet of timber, valued at about $474 million dollars, was harvested from private and public timberlands in 2007. Rangelands are native or naturalized grasslands, shrublands, deserts and open woodlands which have primarily been used for livestock grazing. They cover about 47 million acres of California's wildlands. For the purposes of this chapter, climate impact discussion and adaptation strategies focus mostly on ecosystems supporting tree cover, i.e., forests and oak woodlands (hardwood range). In addition to traditional economic uses of these working landscapes, California's forests and rangelands provide important environmental and economic benefits such as watershed protection, carbon sequestration and storage, biomass for energy production, recreation, and wildlife habitat for wildlife.

Climate change in California forests may affect tree survival and growth, forest composition, forest health and productivity, and will likely increase the intensity of ecosystem disturbances from wildfire, insects and pathogens. Population growth and land use change may create additional stresses that increase vulnerability to impacts from climate change. The interaction of these forces may reduce or change the range of ecosystem goods and services available for wildlife and watersheds, citizens, communities, and businesses.

Future Climate Impacts to Forest and Rangeland Resources

A. Increased Temperature and Extreme Events

Temperature rise affects plant species behavior, including seed production, seedling establishment, growth and vigor. It also reduces moisture availability for plants, increases the risk of wildfire, and is likely to enhance the survival and spread of insects and possibly pathogens. These effects could change the survival, distribution and composition of rangeland and forest habitats. A recent analysis of tree mortality information collected over the last five decades in the Western United States, including older established Sierran forests, determined that trees have been dying at a faster rate in recent decades as a result of increasing regional temperatures and climate change.[1]

With warmer temperatures, tree species in California may respond by migrating both northward and to higher altitudes.[2] Recent research concluded that upslope movement of pine forests and oak woodland conversions to grassland have already occurred due to climate change.[3] As the rate of climate change increases some tree species may not be able to adapt to changed conditions. Species with currently restricted ranges will probably be most vulnerable, while species with broader climate tolerances may be able to adapt more easily. Alpine forests and associated plant species are particularly vulnerable because they have little room to expand. Ecologists also no longer assume that plant communities will migrate intact, so forest and range communities may change in species composition as they move.

The scenarios reviewed for the 2009 Scenarios Assessment show – inconclusively at this time –potential increases and decreases in forest productivity due to temperature and climate change.[4] Other researchers modeled interactions of temperature, wildfire, CO_2, and other climate effects. The results have been in predicted declines in conifer forests, oak woodland savanna and chaparral but increases in hardwood forests and grasslands.[5]

In areas where water availability is adequate for growth, warmer average temperatures will potentially extend the growing season and allow forests to expand. A wetter climate model predicted that woody biomass would increase over the next century, while a drier climate model predicted a decrease in woody biomass.[6] A study modelling ponoderosa pine plantation growth showed 9 to 28 percent increases in tree volume by the end of the century, primarily due to higher temperatures.[7] Ponderosa pine is an important commercial species, thus climate change could be economically beneficial in some areas.

Forestry Impacts due to Warming

- Enhanced and/or Decreased Forest Productivity
- Tree Mortality
- Species Migration Barriers
- Invasive Species Increases
- Changes in Natural Community Structure
- Spread of Diseases & Insects
- Reduction in Ecosystem Goods and Services

Higher daily and seasonal temperatures will affect insect pest and disease life cycles and processes as winters become milder. Pests such as the mountain pine beetle have already expanded their range and have increased overall fecundity due to warmer average temperatures (Figures 19 and 20).[8] A 2 °F increase in annual average temperature allows mountain pine beetle to complete its life cycle in one year versus two.[9]

Figures 19 and 20: *Bark Beetle Damage- Forest mortality has increased in recent decades as tree-damaging pests expand their range with warmer temperatures*

Many invasive plant, insect and disease species are successful at colonizing new areas precisely because they have a broad tolerance of physical conditions. As such, warmer average temperatures may make California rangelands and forests more hospitable for species that are new to the area. This could compound the loss of California's native species, increase costs for removal of invasive species, and potentially bring new species of commercial value to California's timberlands.
Temperature rise also reduces moisture availability for vegetation. Warmer, shorter winters result in earlier snowmelt and spring runoff, which can mean longer dry periods in the summer months and reduced moisture for plant use. These factors have also been implicated in earlier and longer fire

seasons.[10] Some models suggest that these snowpack losses are likely to occur more quickly in milder climates and at lower elevations; while slower losses are predicted at higher elevations.[11]

B. Precipitation Changes and Extreme Events

Climate change may affect precipitation and hydrology, which are critical drivers in forest and range ecosystems, in several ways. Recent winters have been warmer and snowmelt has begun earlier.[12] In addition, a greater percentage of precipitation is already falling, and will continue to fall, in the form of rain rather than snow.[13] Less snowpack and the temporal changes in snowmelt and spring runoff can lead to longer dry periods in summer months, reducing available moisture for forest plants. Moisture deficits may, however, be somewhat offset by increases of atmospheric carbon dioxide which generally cause plants to increase their water use efficiency.[14] Earlier snowmelt will also affect wildlife behavior, and this could affect forests. For example, the early emergence of denning bears could result in greater localized tree damage, tree stress and lower forest health.

While the results of precipitation models vary, recent models lean toward predictions of a drier future for California.[15] Declines in precipitation and drier cycles will increase the risk of drought. The effects of a prolonged drought on forests will depend on the species present, their life stages, soil texture and depth, and the duration and severity of the drought.[16]

A lack of consistently available moisture can impact forest health, although some regions and forest types will be impacted more than others. For example, declines in precipitation may have significant impact on those inland forests that are drier as compared to coastal forests which receive moisture through coastal fog. Climate change may, however, also result in decreased fog regimes.[17]

In the short-term, forest trees will respond to increased drought by limiting growth and reducing water use. While adult trees, with their deeper root system and stored nutrients and carbohydrates, will be able to survive short-term droughts, new seedlings and saplings may be unable to establish. Under prolonged drought conditions trees and shrubs may weaken and become more susceptible to pests, disease and wildfires, and some plant communities may be more vulnerable to invasive species. Reforestation success may be improved by management practices that use more drought tolerant species or genotypes, by changes in stocking, and other silvicultural practices.

Forestry Impacts due to Precipitation Changes

- Longer Dry Periods and Moisture Deficits
- Potential for Increased Growth from CO_2
- Competitive Species Interaction
- Increased Flooding & Runoff - Increases Erosion and Nutrient Loss
- Drought Conditions
  - Limits Seedling and Sapling Growth
  - Increase Wildfire Risk
  - Economic Losses

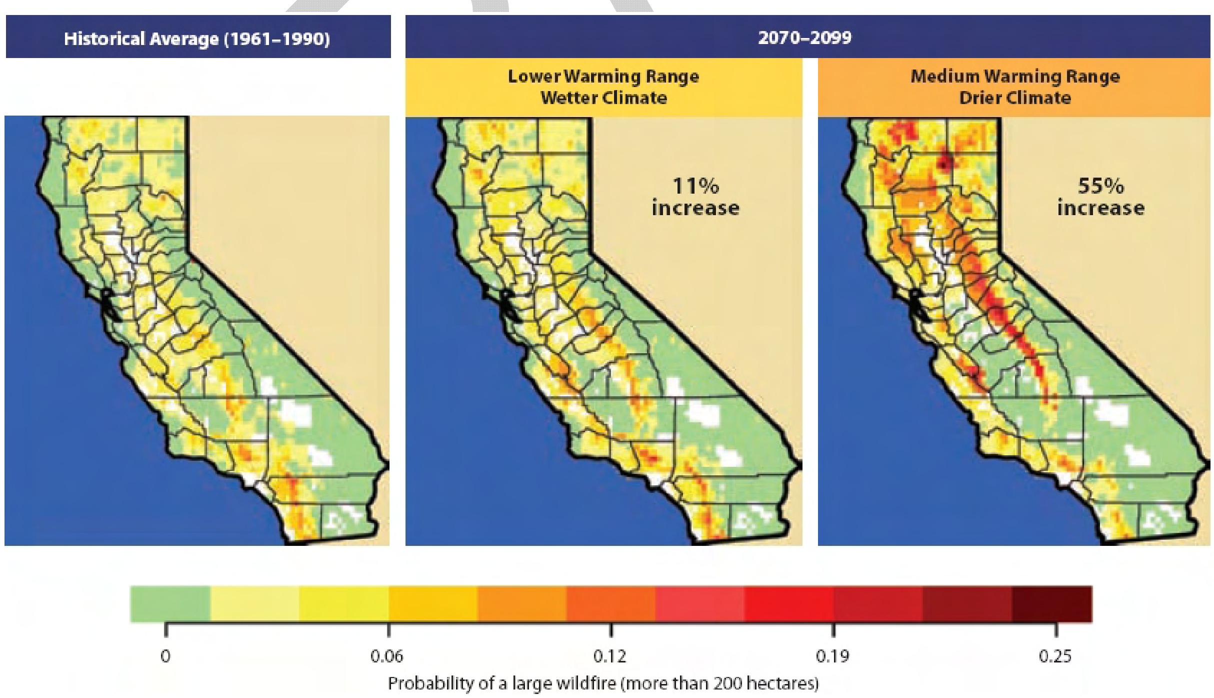
Climate change may result in other precipitation extremes. While total average annual rainfall may decrease only slightly, rainfall is predicted to occur in fewer, more intense precipitation events. More intense weather events may result in high runoff and flooding, which can cause soil erosion and landslides. These events can impact watersheds, habitats, structures and public safety, integrity of road systems and other infrastructure and forest site productivity. Effects can be devastating when they follow wildfires that denude and destabilized slopes, as seen in “fire/flood” sequences in southern California.

Wildfires

Wildfires are an intrinsic part of California's forest and rangeland ecosystems. Our native habitats have evolved with and adapted to periodic wildfire disturbance. Predicting future change requires a basic understanding of the complexity of fire regimes and responses endemic to the natural systems of California. Fires are intrinsically variable events. While one fire may produce a negative impact in a particular area, a different fire might prove beneficial. Thus, only by understanding how natural regimes impact specific ecosystems can we understand and respond to the demands that climate change places on managing forests. In simple terms, we must try to emphasize "good" fires, and limit "bad" fires in the context of different ecosystems. While many species such as lodgepole, Coulter, knobcone and Bishop pines actually require fire of moderate to high severity disturbance for seed dispersal, other systems (e.g., ponderosa pine and oak woodland) exhibit undesirably high mortality rates when burned at high severity. Many chaparral brush species also regenerate readily by seed and vegetative re-sprouting after fires. By matching the treatments to the natural regime effects, managers can best capture the beneficial effects of wildfires. For example, low-intensity wildfires consume dead and downed vegetation (surface fuels) restore soil nutrients, clear underbrush, and thin out tree canopies, thus allowing new growth. Often, post-fire environments support better wildlife forage due to increases in palatable new growth.

In recent decades, however, the wildfire season appears to be starting sooner, lasting longer, and increasing in intensity.[18] Fuel buildup from years of fire suppression and past management practices, in concert with changing climate, contribute to increasing fire hazards that threaten life and property, air quality, watersheds and water quality, terrestrial and aquatic habitats, recreation and tourism, timber resources and other goods and services. Over 48 million acres, or nearly half of the state, is at a high to extreme level of fire threat.[19] Climate change will greatly influence the size, severity, duration, and frequency of fires. Rising temperatures will produce drier fuel conditions and increase moisture stress, likely impacting forest health and increasing susceptibility to pathogens and insects. These stressors, in turn, will further increase fire hazard.

Figure 21: *Increasing Probability of Large Wildfires in California*



Research suggests that large fires and burned acreage will increase throughout the century. A recent study found that wildfire occurrence statewide could increase by as much as 37 to 94 percent by 2085 under the A2 (higher) emissions scenario.[20] Increased wildfire has been identified as one of the most potentially significant climate change impacts to forested ecosystems. Also, following recently identified trends, fire severity is predicted to increase as a result of climate change manifesting more frequent severe fire weather.[21]

Increases in the frequency and intensity of wildfires will make forests more susceptible to vegetation conversions from trees to brush or grasslands.[22] In order for trees to reestablish after wildfires, patches of living trees must be left to provide seeds for the recruitment of new seedlings. As wildfires increase in size, they can result in “stand replacing” burns that are too big for natural regeneration. More frequent fires may also result in vegetation conversion by repeatedly killing regeneration. Vegetation conversions can impact biodiversity, habitats, watershed conditions, timber resources and other goods and services.

On rangelands, climate change induced wildfire increases are predicted to increase grassland acreage, while decreasing brush and oak woodlands.[23] Wildfires may increase invasion by annual and brush nonnative species, which are generally less palatable to livestock and wildlife than native grass and brush species. Annual grasses also increase fire risk and hazard by producing “flashy fuels” that ignite easily and carry fire quickly across the landscape.

Larger and more frequent wildfires will impact California’s economy by increasing fire suppression and emergency response costs, damages to homes and structures, interagency post-fire recovery costs, and damage to timber, water supplies, recreation use and tourism. The California Department of Forestry and Fire Protection (Cal/Fire) spent over $500 million on fire suppression during fiscal year 2007/2008. As climate change continues these costs are expected to increase.

Proper fuel management, strategically placed, can effectively reduce hazard and risk and help restore vegetation conditions that are more resistant to wildfire damage. Fuel reduction also mitigates climate change by reducing GHG wildfire emissions and providing biomass for energy production as a fossil fuel alternative. Fuels management to restore more fire resistant forest conditions can be accomplished through prescribed fire, manual and mechanical treatments, or a combination of methods.

Over 200,000 acres of fuel management is conducted annually by federal and state agencies with natural resource protection responsibilities (i.e., US Forest Service, BLM (Bureau of Land Management), BIA (Bureau of Indian Affairs), NPS (National Park Service), NFW (National Fish and Wildlife Foundation), CAL FIRE, DPR (Department of Parks and Recreation)), The USFS conducts fuel management and forest health improvement on about 100,000 acres of their lands per year.[24] Prescribed fire is used on about 40 percent of the area and mechanical or other treatments on 60 percent. CAL FIRE has been treating about 16,500 acres per year on private lands (about 10,000 acres through prescribed burning and 6,500 with manual and mechanical treatments).[25] Federal grants are also been provided for community fire hazard reduction through the California Fire Safe Council. These efforts typically treat only a fraction of the area now at risk for high intensity fire.

Based on the area of ecosystems that historically supported frequent low-severity fire regimes, the potential need for prescribed burning or other treatments that restore fire resistant ecosystem conditions may be estimated at over a million acres per year. While prescribed burning treatments can be less expensive to conduct, in many cases, reintroduction of fire is not prudent until heavy understory and ladder fuel hazards have been treated through alternative means (e.g., mechanical treatments). Air quality impacts and public safety concerns about fire escapes can also impact the feasibility and costs of using prescribed fire. (See the Biodiversity and Habit chapter for more discussion of ecological concerns.)

C. Sea-Level Rise

Sea-level rise poses minimal threats to forest stands. The convergence of sea-level rise and storm surges may, however, damage road systems in low lying forested areas right along the coast. This will impact residential access, timber management, recreation, and tourism uses of the landscape.

D. Risks for Forestry

The changing risks faced by California's forestry sector have been qualitatively assessed and the projected consequences for California's forests and woodlands are characterized as follows:

- The most significant climate change risk facing California is associated with an increase in wildfire activity. Warmer weather, reduced snowpack and earlier snowmelt can be expected to increase fuel hazards and ignition risks. It can also increase plant moisture stress and insect populations, both of which impact forest health and reduce forest resilience to wildfires. An increase in wildfire intensity and extent will increase public safety risks, property damage, fire suppression and emergency response costs to government, watershed and water quality impacts, vegetation conversions and habitat fragmentation.

- Climate change may dramatically change forested and range landscapes, resulting in expansions of some forest and woodland types, contraction of others, and conversions to brush and grassland habitats. These will affect biodiversity and may impact habitat availability, quality and connectivity. It may also affect economic uses, such as timber harvest, though net interactions of growth, wildfire, lumber markets and other effects are hard to predict.

- Temperature rise may enhance and expand insect populations, resulting in increased mortality. This would impact timber resources and reduce habitat quality for some species. It also increases fuel hazards and the likelihood for more intense, stand replacing fires that impact timber resources, fragment habitats, threaten life and property and damage watersheds.

- Climate change may result in increased establishment of non-native species, particularly in rangelands where invasive species are already a problem. These species may be able to exploit temperature or precipitation changes, or to quickly occupy areas denuded by fire, insect mortality or other climate change effects on the vegetation.

Forestry Adaptation Strategies

Introduction

The state agency that participated in the Climate Adaptation Working Group (CAL FIRE) developed the following strategies and shall be responsible for and will spearhead strategy implementation for the state. Developing a successful comprehensive forestry adaptation strategy will, however, require working across agencies and with public and private landowners. Collaboration among federal and state resource protection agencies, landowning agencies, industry and non-industrial forest landowners, and other stakeholders is essential. The U.S. Forest Service, which owns over 13 million acres of forests and woodlands, will be an important partner in this effort.

Recent research has focused on the nature of successful adaptation strategies for minimizing the threats to forests resulting from climate change. Following the findings of some researchers, adaptation can be thought of in terms of three broad strategy constructs, from which a variety of specific actions can follow.[26] Resistance refers to either forestalling or protecting key areas from harm, and is generally considered a near-term strategy to highlight high-vulnerability/high-value resources and to target actions that defend those resources against change. An example would be a particularly sensitive habitat that fires are expected to destroy. The resistance adaptation would be to put in place fire prevention and hazard reduction projects to reduce the risk from future wildfires by making fire in the habitat area less likely.

Resilience strategies emphasize transforming currently vulnerable systems into less vulnerable ones, much like how preventative health care is designed to mitigate future medical problems. This is a more mid-term level approach that requires systematic understanding of how fires impact key assets, and how the fire environment can be modified to reduce damage. The classic example is treating high hazard mixed-confer forests through fuel modifications to make future fires in low-severity systems low severity events, rather than the high severity events that might be expected under current fuel conditions. This approach has the added benefit of also being a climate change mitigation strategy in that it promotes carbon sequestration and limits CO_2 flux from future wildfires.

Finally, a Response strategy refers to pushing system effects in a beneficial way, and is typically viewed as a long-term strategy, in that ecological response is required to be conducted through successional time. As such, this strategy does not avoid change, it accommodates it.

Treatments in this strategy would try to mimic or expand on natural adaptive processes that allow natural systems to respond to changing environmental conditions as all systems have developed over ecological time. Thus, treatments designed to improve dispersal, colonization, migration, etc. all can be viewed as promoting response. By encouraging gradual adaptation to a changing climate, the idea is to avoid rapid and often catastrophic conversions that might otherwise occur.

Adaptation Strategies and Actions

Assessment and planning

While forests inherently contain the ability to adapt to a changing climate, rapid climate change may result in significant disruptions of existing forest and range habitat structure and the goods and services we receive from them. Management actions, therefore, should enhance the resiliency of existing forests where possible, and facilitate the establishment of future stands that are more tolerant or able to exploit future climate conditions. Planning should include short and long term strategies, monitoring for unanticipated climate effects and for effectiveness of adaptation strategies, and flexibility to manage adaptively and make adjustments as we go.

CAL FIRE will continue to refine its understanding of wildland vulnerability to climate change. The Fire and Resource Assessment Program (FRAP) is updating a chapter on climate change in its Forest and Rangeland Resources Assessment. The climate change chapter will incorporate information on Fire Hazard Severity Zone mapping, recent revisions to CAL FIRE's Vegetation Management Program EIR, and climate research conducted by FRAP personnel. The assessment, which will be finished in 2010, will inform climate policy development, strategic planning, and implementation of the AB 32 Scoping Plan's Sustainable Forests target by the Board of Forestry and Fire Protection (BOF).

In order to meet the threat of increasing wildfires, CAL FIRE will focus adaptation activities on pre-fire management and fire suppression. It will work with the BOF to revise the State Fire Plan by January 2010. The plan will consider policies and programs for defensible space (fuels treatments and fire safe development standards), land use planning (timberland conversions, development projects, and fire protection responsibility), ignition resistant building standards, fire suppression deployment based on hazard/risk rating, and restoration and rehabilitation. By 2009, CAL FIRE will also have made recommendations for Very High Fire Hazard Severity Zone classification of over 200 cities in Local Responsibility Areas, which can be used to implement adaptation activities for increasing fuel reduction and improving structural resistance to wildfire. CAL FIRE will also encourage local entities to reduce fire risks and hazards and to enhance disaster readiness planning for escape routes and evacuation.

Fire Hazard Reduction and Fire Suppression

CAL FIRE has several programs that support vegetation management and fuel hazard reduction activities (mechanical treatments and prescribed burning). These can be used to increase forest health and resilience to climate impacts. Although state funding for the Proposition 40 Sierra Nevada Fuels Reduction Program expires this year, CAL FIRE is anticipating a $13.5 million-dollar, one-time federal fuels management grant and is actively pursuing other potential funding sources.

In recent years, both state and federal fuel reduction priorities have focused on the wildland urban interface (WUI), the area where at-risk forests and rangelands meet structure and human development. The WUI's proximity to communities makes mechanical treatments often more acceptable than prescribed fire, due to concerns about fire escape, life and property damage, and smoke impacts. In 2001, federal agencies and the Western Governors' Association approved "A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment," a 10-year strategy to improve fire suppression, prevention, fuels reduction and recovery, and to restore fire adapted ecosystems through collaboration among states, federal agencies and stakeholders. The plan includes the use of prescribed fire, mechanical treatments and wildland fire use, and seeks to reduce barriers to treatments through policies and incentives. [27]

Biomass utilization can help offset the cost of vegetation management and fuels reduction activities to reduce fire risk and create healthier, more resilient forests. In addition to promoting healthy forests and defensible communities, biomass utilization of these materials reduces landfill waste, provides net air quality benefits over open slash burning, and contributes to economic and job development. Sustainable biomass utilization for energy production will reduce GHG emissions because emissions are carbon neutral. CAL FIRE is partnering with agencies, academia and other organizations to address technical and policy challenges to increased forest biomass utilization. CAL FIRE is developing a plan for a small demonstration biomass-to-electricity plant in Mendocino County which will be completed by December 2010. It is also working with the California Biomass Collaborative (CBC) and the California Energy Commission to inventory available forest biomass and to evaluate the potential for "Biomass Management Zones" (report due December 2009).

Ignition resistant building construction is also critical to reducing fire hazard and risk to life and property in wildland-urban interface (WUI) fires. These conflagrations, though not necessarily large (e.g., 1991 Oakland Tunnel Fire, at 1,600 acres), can overwhelm fire suppression and result in 80 to 90 percent destruction of ignited buildings. The State Fire Marshal has begun a revision of the California Building Code Chapter 7A, "Materials and Construction Methods for Exterior Wildfire Exposure" to develop more comprehensive hazard mitigation measures. The revision will be completed January 2010.

CAL FIRE has already increased fire suppression readiness to meet changing climate conditions. A year round fire season was established and staffed in southern California, and recommendations from the Governor's Blue Ribbon Commission are being implemented to replace aging fire engines and to provide a higher level of firefighter safety. Emerging remote sensing technologies are being tested on major fires to provide real time planning tools to incident commanders and fire managers, and new air tanker platforms, including the DC-10, are being evaluated for large and remote fires. Recent Governor Executive Orders have also provided increased staffing, additional aircraft availability and other support for periods of critical fuel and weather conditions.

Reforestation, Urban Forestry and Forestland Conservation

Adaptive approaches to forest regeneration can increase resilience in the short and long-term by adjusting silvicultural practices to establish forests that are more tolerant of future climate conditions. This includes planting genetically appropriate species that will be better adapted to changed climate conditions than the genotypes currently on site. CAL FIRE's L.A. Moran Reforestation Center seedbank catalogues and stores approximately 42,000 pounds of primarily native conifer seeds which are available for replanting forest stands after fires, insect or disease outbreaks, or other catastrophic events. Its greenhouse facilities have capacity for up to 400,000 container seedlings per year, but have gone unused for seven years due to inadequate funding. CAL FIRE's Magalia Reforestation Center has the capacity to produce up to 2.5 million bare-root seedlings and 40-50,000 container seedlings per year. These facilities could be brought back on line relatively quickly and inexpensively if funds for operating and staffing were provided.

Urban forestry has a significant role in adaptation to rising temperature and precipitation runoff events. Increased street tree cover provides shade relief to pedestrians and other residents, absorbs pollutants including ozone and CO_2 which may increase with climate change, and reduces stormwater pollution and flooding. A ten percent increase in vegetation cover can reduce ambient temperatures by 1 to 2 degrees. Urban forests also provide significant co-benefits, reducing habitat fragmentation and mitigating GHG emissions through sequestration and by reducing energy use for buildings. CAL FIRE urban forestry activities, funded through state bonds authorized under Propositions 40 and 84, help plant trees and support local agencies and non-profits in planning, implementing and monitoring urban forestry programs. CAL FIRE helped develop urban forestry carbon protocols to provide incentives for increased urban forest development, and will continue to work with local and federal agencies, private and non-profit sector to expand and enhance urban forests.

Development pressures on forestlands are increasing due to declining profitability from timber management and demand for rural subdivisions and vineyards. Forestland conversion fragments forested ecosystems, reducing forest health and capacity for carbon sequestration, degrading and eliminating wildlife habitat and isolating populations of forest species , increasing wildfire risk, and complicating wildland fire suppression efforts. CAL FIRE is proposing revisions to the CEQA guidelines to incorporate more protection for forestland and will work with the Board of Forestry and Fire Protection over the next 18 months to improve review and permitting for forest, timberland and Timberland Production Zone (TPZ) conversions.

Strategies and Actions

The following list of strategies and actions by the Department of Fire and Forestry (CAL FIRE) elaborates on the discussion above and identifies additional activities for addressing climate adaptation. The strategies include both near term actions **-** those recommendations that have been identified, proposed, initiated, or can be completed by 2010. The long term actions identified include those recommendations that will require additional collaborative efforts with multiple state agencies, as well as sustainable funding and long-term state support.

Strategy 1: Incorporate Existing Climate Information into Policy Development and Program Planning.

<u>Near-Term Actions:</u>

a. **Comprehensive Program Integration** – Integrate climate risk information into existing CAL FIRE program planning to address forest and range adaptation. CAL FIRE program managers should identify key climate effects or uncertainties that may affect implementation of a broad range of programs including: Forestry Assistance, State Forests, Forest Practices Regulations, Fire Protection, Fire Prevention, Unit Fire Plans, and Capital Outlay.

b. **Identify and Engage Stakeholders –** CAL FIRE will fully engage Forest Sector and cross-sector stakeholders in identifying key impact and adaptation concerns and questions as they relate to agency responsibilities and services. [e.g., U.S. Forest Service (USFS), Bureau of Land Management (BLM), National Park Service, National Marine Fisheries Service, U.S. Fish and Wildlife Service, State Department of Fish and Game (DFG), State Parks, regional air boards, regional water quality boards and other state agencies, local governments, private landowners, community groups and Non-Government Organizations (NGO)].

c. **Forest and Rangeland Resource Assessment** – CAL FIRE is required by statute to periodically assess the condition and availability of the state's forest and rangeland natural resources. The update will expand upon the previous climate change chapter to inform the Board of Forestry and Fire Protection's (BOF) climate policy, strategic plan and climate change actions. The draft plan will be developed, reviewed by the public, and considered for BOF approval by the end of 2009, and finalized in 2010.

d. **Timber harvest planning under the Forest Practices Act** - Provide guidance for project proponents and CAL FIRE staff to address climate impacts and adaptation actions within existing maximum sustained timber yield production plans required by the California Forest Practices Act.

<u>Long-Term Actions:</u>

e. **Build Institutional Capacity** Update policies and CAL FIRE Handbook and activity guidelines.

Strategy 2: Improve Institutional Capacity for Data Development and Analysis, Assess Climate Effects and Forest Vulnerabilities, and Recommend Strategic and Tactical Responses.

<u>Near-Term Actions:</u>

a. **Vulnerability & Risk Assessment** – CAL FIRE will conduct strategic risk analyses and vulnerability assessments to identify and prioritize planning and tactical actions to address adaptation needs. Included in this is the deliberate development of quantitative risk modeling of fire impacts on key assets and resources in a spatially explicit framework. A major portion of this work involves projecting future fire probabilities and future vegetation/fuel conditions across the state.

b. **Policy Actions** – Begin to develop policy, management and funding recommendations for actions by Board of Forestry and Fire Protection, CAL FIRE, other agencies (including USFS) and private sector to increase resilience of forest lands and resources.

<u>Long-Term Actions:</u>

c. **Improve Data and Modeling Capabilities** – Fill major data gaps for strategic planning and assessment by CAL FIRE and other programs.

d. **Improve Scientific Knowledge Base** – CAL FIRE programs, such as the Fire and Resource Assessment Program, will work with Scripps, UC, USFS, Energy Commission and others to refine climate models for CAL FIRE Fire Protection and Resource Management Programs.

Strategy 3 - Actions to Address Climate Vulnerabilities (Sector Preparedness Action Plan)

<u>Near-Term Actions:</u>

a. **Management of Forest and Range Lands for Resilience** – In cooperation with federal, state and local agencies, CAL FIRE plans to reduce the vulnerability of forests to disturbances from climate change impacts. Specific actions include:

   i. **Expand Landowner Assistance and Technology Transfer** – CAL FIRE's Forest Improvement Program will work with the US Forest Service, University of California Extension, Resource Conservation Districts (RCDs), Natural Resource Conservation Service and others to prevent and minimize catastrophic wildfire and restore fire resistant conditions in fire adapted vegetation types through mechanical and prescribed fire treatments, and to assist with post-fire recovery.

   ii. **Review Regulatory Framework** – The Board of Forestry and CAL FIRE's Forest Practices, Fire Protection and State Fire Marshal programs will review and consider the need for regulatory and related improvements as well as revisions to CAL FIRE Handbook.

   iii. **Support Urban Forestry** – Funded through Propositions 40 and 84, CAL FIRE's Urban Forestry Program will continue to assist local entities with tree planting and urban forest management. This will help protect and expand urban forests that serve to buffer the impacts of local wildland forests, and provide sequestration, watershed, water quality and habitat co-benefits.

b. **Department established as "Trustee" agency in CEQA** – Establishing the Department as a Trustee agency in CEQA will provide assurance that new projects and development provide mitigation that is consistent with adaptation goals, including fire safety and forestland conservation and maintenance.

<u>Long-Term Actions:</u>

c. **Reduce Fire Risk, Hazards and Emissions** – CAL FIRE will work with state agencies such as Fish and Game, Parks and Recreation, Sierra Nevada Conservancy, Tahoe Conservancy and Dept. of Water Resources, with landowners and local government, and with federal agencies, including USFS and others, to identify high value and high risk natural resource areas (e.g., habitats and corridors, watersheds, parks, timberlands) and to increase fuels management and restore fire resistant forest conditions where appropriate through mechanical and prescribed fire fuel treatments.

d. **Support Restoration Activities** – CFIP and Nurseries will work with state agencies such as DFG and DPR, USFS, landowners, and others to develop technical assistance and guidance materials.

e. **Seedbank and Nursery Support** – CAL FIRE will work with the USFS and private sector to improve long-term seedbanks and nurseries in order to secure genetically appropriate varieties for future plantings and to preserve genetic legacies.

f. **Rangeland Adaptation** – CAL FIRE will cooperate with the Board of Forestry and Fire Protection and its Range Management Advisory Committee, state agencies, the University, and the private sector to promote research on carbon cycling benefits and rangeland management climate benefits.

g. **Promote Adaptation in Land Use, Public Safety and Economic Infrastructure** – Promote an active response by communities and other institutions to improve land use planning and implementation to reduce conversion and wildfire risks. Specific actions needed include:

i. **Determine Regional Readiness to Respond to Disasters** – CAL FIRE's Fire Protection Program should work with governmental agencies and others to examine the climate impacts resulting from more frequent extreme natural events such as floods and wildfire and the ability of regional or statewide resources to respond**.**

ii. **Improve Local Land Use Planning Support** – CAL FIRE's Fire Protection Program and State Fire Marshall (SFM) will work with local agencies and groups to decrease risk and hazards and increase public safety options**.**

iii. **Factor Climate Change into Planning for Fire Protection Services** – CAL FIRE will encourage other state agencies, cities, counties, special districts and community-based non-profits such as Fire Safe Councils to develop local fire management plans that explicitly evaluate climate change impacts as part of the planning process. Fire management plans should identify risks, vulnerabilities, and preventative measures to cope with climate change.

iv. **Minimize impacts of Development** – CAL FIRE will work with other agencies to incorporate adaptation concerns into environmental review and permitting (e.g., timberland conversion, County General Plans, subdivision development review and individual development projects)**.**

v. **Improve Utilization of Forest Carbon Stocks** –CAL FIRE and Board of Forestry and Fire Protection will work with state agencies, industry, the Legislature and others to ensure adequate infrastructure for biomass utilization and traditional wood products**.**

vi. **Improve Opportunities for Rangeland Management Adaptation** – CAL FIRE will cooperate with the Board of Forestry and Fire Protection, the Range Management Advisory Committee, and the Dept. of Food and Agriculture to support private sector efforts to identify economic opportunities for climate adaptation, including invasive weed control, fire hazard reduction, watershed restoration and livestock management.

vii. **Post fire vegetation management** - The Department will strengthen the efforts following large damaging fire in guiding management of the vegetation regrowth or restoration. By investing in vegetation management following a fire the conditions under which the next fire will burn are changed. Smaller investments of resources are needed to manage vegetation following a fire than when applied to dense pre-fire vegetation.

h. **Identify Investment Options and Other Strategies to Address Climate Adaptation** – The state, CAL FIRE and the Board of Forestry and Fire Protection will initiate efforts to build public support for long term investments in public and private forestlands and develop a robust set of options to address adaptation needs for the protection of forest and range land resources.

<u>Near-Term Actions:</u>

i. **Explore Cross Agency and Sector Synergies** – The state, though the Climate Action Team and the California Natural Resources Agency should promote coordination among state planning processes, grant and assistance programs, and management activities on climate actions with high co-benefits. CAL FIRE will collaborate with other agencies on their adaptation strategies and with programs that increase forest resilience (e.g., with ARB to explore funding opportunities from cap and trade markets for activities with both mitigation and adaptation benefits; with WCB on Prop 84 forest conservation; with DWR, DFG, and the California Department of Conservation to implement upper watershed protection and riparian reforestation; with DFG to identify, protect and improve the resilience of critical habitats at wildfire risk; with Energy Commission and others on Renewable Portfolio Standard (RPS) implementation to increase funding for fuels reduction; with OPR on CEQA and land use planning tools; and with Sierra Nevada Conservancy Prop 84 fuels reduction and forest restoration).

ii. **Demonstration Project** – CAL FIRE will develop a biomass-to-electricity plant at Mendocino County Conservation Camp to demonstrate the value of small power plants. Planning and funding commitments will be completed by December 2010.

iii. **Maintain Current Wood Product Utilization Capacity** – The Board of Forestry and Fire Protection and CAL FIRE will work with other agencies and the private sector as appropriate to encourage policies and strategies that help maintain utilization infrastructure (sawmills, pulp mills, veneer plants, etc.) and that encourage modernization of existing facilities or development of new facilities.

iv. **Provide Regulatory Certainty** – The Board of Forestry and Fire Protection and CAL FIRE will consider the need for additional incentives, or the removal of disincentives, to encourage landowners to actively manage their lands for adaptation, e.g., cap and trade markets, protocols and RPS implementation.

<u>Long-Term Actions:</u>

v. **Adequately Fund Programs** – Consider development of stable funding sources such as carbon fees, Carbon Trust, and public goods charges.

vi. **Encourage Market Development** – The Board of Forestry and Fire Protection is collaborating with the U.S. Forest Service to encourage investment in bio-energy facilities. The Board will consider the role of biomass utilization in the California Fire Plan revision by January, 2010.

Strategy 4 - Implement Priority Research Agenda

CAL FIRE will work with California Energy Commission's PIER Program (Climate Action Team), Air Resources Board, University of California and other research entities to identify and fill knowledge gaps related to climate adaptation and evaluate the most effective strategies. Potential research options include:

<u>Long-Term Actions:</u>

a. **Fill research gaps, including, but not restricted to, the following topics:**

i. Urban Forests and Climate Change: Comprehensive Cost and Benefit Analysis

ii. Predictive Tree Biomass Model Evaluation and Improvement

iii. Wildfire GHG Emission Analysis: Standardized Estimation Methodologies

iv. Life-Cycle Characterization of Forest Carbon Pools and Wood Products in California

v. Forest Landowner Profile Development: Current and Projected Forest Conditions and Landowner Participation in Programs and Markets

vi. Improved Forest Research and Management Tools: Climate Smart Forest Projections and Risk Assessments for Pests and Fire

vii. Forest Bioenergy and Biofuel GHG Profile Characterization

viii. Climate Change and Forests Research and Monitoring Infrastructure Development: Joint Strategic Planning

ix. Quantification of managed fire versus wild fire GHG emissions in California forests.

x. Risk and prevention analysis of catastrophic tree mortality in California forests and woodlands from parasitic and exotic insects and disease.

xi. A comprehensive monitoring and adaptive management program to quantify the effects on climate change and the effectiveness of adaptation strategies.

xii. Improved analysis of timberland conversion trends and effects.

xiii. Economic analysis of cross sector effects of investments, e.g. looking at feed-in tariff for biomass based electricity on the cost of fire suppression.

Strategy 5 - Implement Forest Health Monitoring in an Adaptive Management Context

Monitoring programs for detecting climate change, effects on vegetation and management results are needed to support adaptation planning and management. CAL FIRE will work with the California Natural Resources Agency and others to determine and implement key monitoring needs, including forest health trends, land use and management change, and effectiveness of adaptation actions.

<u>Long Term Actions:</u>

a. **Define Indicators** – Development of ecosystem and other climate related indicators that show or measure trends.

b. **Establish Monitoring Criteria** – Establish a network of long term monitoring plots that are implemented across both longitudinal and elevation gradients to detect climate change impacts

c. **Continue and Expand Pest Detection** – Support existing programs that can provide early detection of insects, disease, and drought in forest and range lands.

d. **Establish Adaptive Management Criteria** – Identify feedback process to inform and, as necessary, adjust policy, strategies, and regulatory approaches.

e. **Monitor Changes in Land Use** – Acres of growth and loss of forest cover as well as resulting carbon stock effects.

f. **Interagency Cooperation** – Collaborate with other state agencies to leverage limited monitoring resources.

X. TRANSPORTATION AND ENERGY INFRASTRUCTURE

Introduction

California's economy and population relies on one of the most extensive and costly infrastructure systems in the world. This includes thousands of miles of roads, highways and railroads, nearly 200 large water reservoirs of varying capacity, miles of canals, the second largest hydropower production in the United States, over 12 of the nation's largest oil reservoirs, hundreds of airports, thousands of bridges, and sea ports that deal in over $200 billion in trade a year. Without this infrastructure, the state would not function as the eighth largest economy in the world.

California's infrastructure was developed to accommodate its highly variable climatic conditions, but it is frequently disrupted by natural disasters such as earthquakes, storms, and floods. Future climate change can directly and indirectly exacerbate these disasters, and add new ones, to California's infrastructure resulting in increased maintenance and repair expenditures, disrupting economic activity, interrupting critical lifelines, and ultimately reducing the overall quality of life for Californians.

To date, there are very few studies providing thorough, comprehensive economic or physical assessments of where California is most vulnerable from future climate change when, and from what specific climate change impacts. More are needed. However, several recent studies shine light on the potential scale of the economic and social impacts from climate change. One recent study from the Pacific Institute estimates that a 1.4 meter sea-level rise over the next century will "put 480,000 people at risk of [what is considered today] a 100 year flood" which would become a common event and cost $100 billion to replace flooded property assuming current levels of development. Another study by researchers at UC Merced and RAND Corporation estimated that by the next 15 to 20 years the cost of wildfires to residential properties could escalate to more than two billion dollars a year and to more than $10 billion a year by the end of this century.[1] Finally, a study by Next10 and U.C. Berkeley estimates that over $2.5 trillion of the state's real estate assets (of $4 trillion) are "at risk from extreme weather events, sea-level rise, and wildfires, with a projected annual price tag of $300 million to $3.9 billion."

In this chapter, *infrastructure* refers largely to transportation and energy-related infrastructure. Other chapters address water and coastal infrastructure strategies and impacts. Future climate adaptation strategy efforts will require a broader look at all infrastructure across California including the private sector and federal and local jurisdictions.

Future Climate Change Impacts to Infrastructure

The most significant climate impacts to California's infrastructure are predicted to be from higher temperatures and extreme weather events across the state, reduced and shifting precipitation patterns in Northern California, and sea-level rise. Higher air temperatures are expected to increase the demand for electricity in the Central Valley and Southern California, especially during hotter summer months, reducing energy production and transmission efficiency while increasing the risk of outages. Potential reductions on precipitation levels could significantly reduce hydropower production which currently accounts for up to 20 percent of the state's electricity supply. Heavy precipitation and increased runoff during winter months are likely to increase the incidence of floods damaging housing, transportation, wastewater, and energy infrastructure. The largest projected damages will come from sea-level rise threatening large portions of California's coastal transportation, housing, and energy-related infrastructure.

A. Increased Temperature and Extreme Events

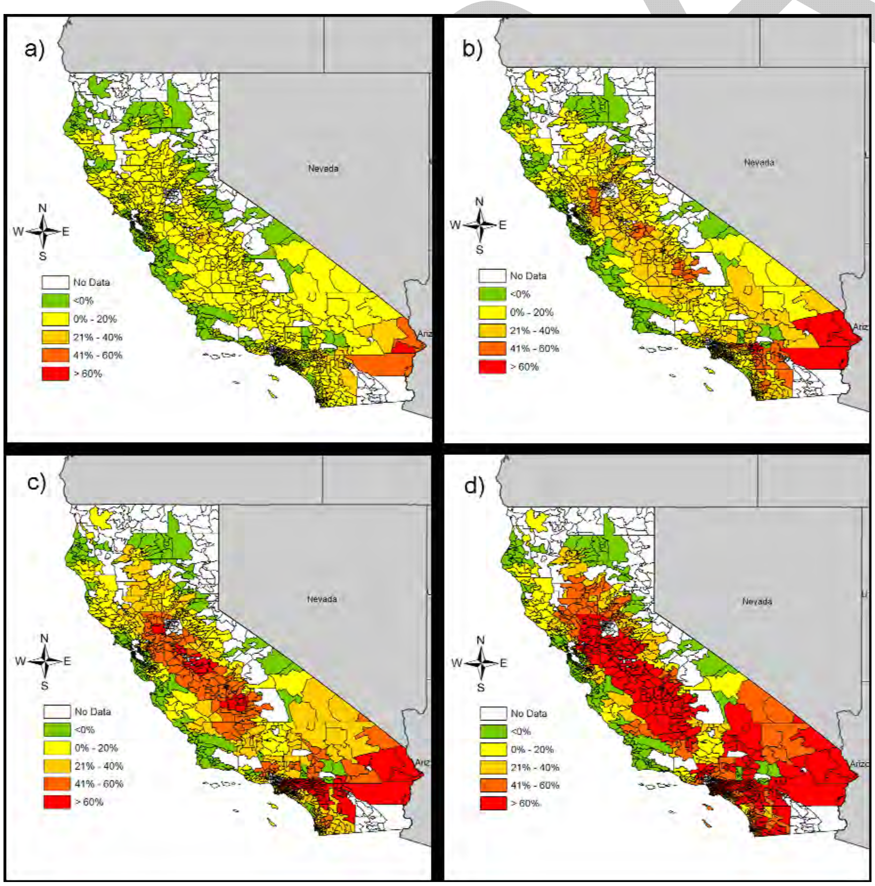
Temperature changes will have direct impacts on energy production, use and distribution and on transportation infrastructure. Average temperature changes are expected to increase energy demands in summer and decrease them in winter. However, with temperatures expected to increase more in summer than in winter in California, wintertime heating demand reduction is likely to be far outweighed by summertime demand increases.[2] Over the past few decades, California's per capita electricity consumption has remained relatively steady due in large part to cost-effective building and appliance efficiency standards and other energy efficiency programs.[3] The *total* consumption, however, has increased substantially along with California's rapidly growing population.

Potential Infrastructure Impacts due to Warming

- Higher Average Temperatures Affect Energy Production, Transmission and Demand
  - Increase in Cooling Demands
  - Decrease in Water Availability for Hydropower Generation
  - Risk of Increased Brown-Outs and Black-Outs
  - Transmission Efficiencies are Impacted in Hot Weather
- Temperature Extremes
  - Increase of Road and Railroad Track Buckling
  - Decrease in Transportation Safety and Higher Costs

Coupled with future population growth, the projected rise in ambient temperatures will increase energy demand for cooling, especially in the Central Valley region where temperatures are predicted to significantly increase.[4] A 2003 study analyzed data for several California cities and found that although previous studies indicate a response rate of two to four percent in electricity use for each degree Celsius increase in ambient temperatures, "long-term climate change will also impact electricity consumption through corresponding increases in the market saturation of air conditioning".[5] A more recent study showed that while California's total domestic electricity demand in the residential sector will most likely increase by a few percent in the next three decades, it could increase more than 60 percent by the end of the 21st century in certain areas, depending upon emissions scenarios.[6] These increases are beyond what is expected from population growth alone.

Figure 22: *Projected Increase in Household Electricity Consumption (from 1980–1999 Simulated Consumption)*
(a) 2020–2039, (b) 2040–2059, (c) 2060–2079, and (d) 2080–2099



In a nationwide review of the available research literature, researchers examined how climate change might affect energy consumption in the United States. Their answer is consistent with

California Energy Commission projections and other regional research relevant to California: "The research evidence is relatively clear that climate warming will mean reductions in total U.S. heating requirements and increases in total cooling requirements for buildings. These changes will vary by region and by season, but they will affect household and business energy costs and their demands on energy supply institutions. In general, the changes imply increased demands for electricity, which supplies virtually all cooling energy services but only some heating services".[7]

Higher temperatures also decrease the efficiency of fossil fuel-burning power plants and energy transmission lines, thus requiring either increased production or improvements in the efficiency of power generation and transmission.[8]

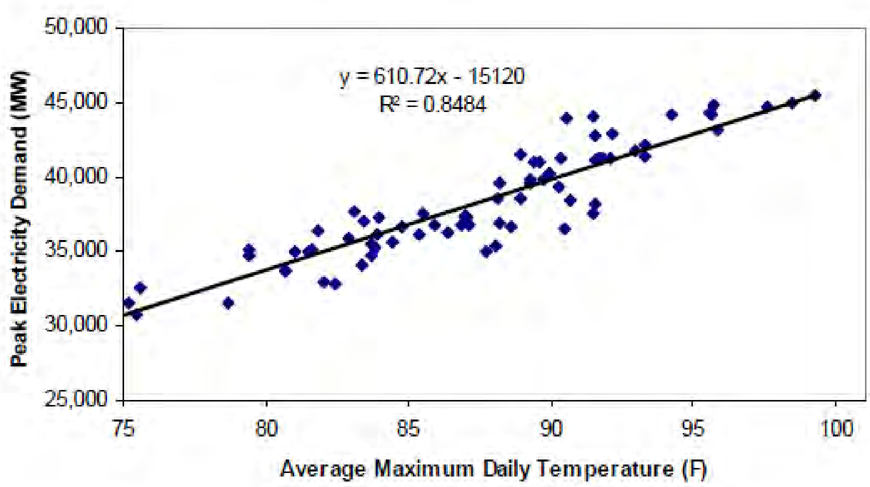
Extreme heat events could cause significant impacts to the energy and transportation sectors. A recent study on extreme heat events and energy demand in California concluded that by 2070-2099 extreme heat events under the IPCC's highest emissions scenario (A1fi) are 20 to 30 percent higher than under the lower scenario (B1) due to temperature differences. The study concluded extreme heat days could double in inland cities like Sacramento and quadruple in coastal cities such as San Diego. Regarding energy supplies, the researchers found California has a 17 percent probability of facing electricity deficits during high-temperature (top 10 percent of historic temperatures) summer electricity demand periods, assuming constant technology and population growth.[9] However, this negative effect could be averted or at least minimized adding more electricity generating units.

POTENTIAL INFRASTRUCTURE IMPACTS DUE TO PRECIPITATION CHANGES

- Climate Changes - Decrease of Hydropower Generation
- Shrinking Snowpack - Affects High Elevation Hydropower Systems with Less Storage Capacity
- Lower River Flows - Requires Increase Release of Water
  - Causing Spills and
  - Reducing Water in Dry Months
- Winter Storms and High Runoff Snowmelt - Results in Flooding and Damage to Transmission Lines
- Extreme Rainfall and Flooding - Causes Wastewater System Overload and Damage to Culverts, Canals and Treatment Facilities
- Increased Flood Damage of Transportation Infrastructure
- More Drought, Fires and Intense Rainfall - Results in Landslides and Disrupt Roadways and Rail Lines

Higher temperatures and heat waves will impact peak electricity demand in California. Figure 23 illustrates how peak temperatures correlate with state electricity load during a peak summer day.

Figure 23: *Peak Electricity Demand June- September 2004*



Temperature extremes are also relevant to the transportation sector. It is expected less extreme cold days will reduce frost heave and road damage,[10] but extreme hot days (including prolonged periods of very hot days), are likely to become more frequent, increasing the risk of buckling of highways and railroad tracks and premature deterioration or failure of transportation infrastructure (Figure 24).[11]

Figure 24: *Trains can derail due to extreme heat warping railroad tracks.*

B. Precipitation Changes and Extreme Events

Fluctuations, and possible total reductions, in California's precipitation patterns will impact several key energy and transportation infrastructure components; primarily hydropower production and all manufacturing and processing operations requiring large volumes of readily available water. In addition, roads, tunnels, airport runways and railroad tracks are likely to be affected by changes in precipitation patterns.

In the energy sector, changes in hydrological patterns will affect the reliability of the region's hydropower generation, which accounts for 12 to 20 percent of the state's total annual electricity generation. A warmer and drier future climate could reduce hydroelectric generation by 19 percent, whereas a wetter future climate could increase hydroelectric generation by 5 percent.[12] Of the 12 climate projections used in the 2008 California Climate Impacts Assessment, only one simulation produced slightly wetter conditions by 2050, and none did so for the end of the century (see Water chapter).
Hydropower production is a significant contributor of energy for electricity suppliers Pacific Gas and Electric Company (PG&E) and the Sacramento Municipal Utility District (SMUD) among many others. SMUD is particularly vulnerable, as hydropower can account for up to 50 percent of its annual power generation.[13]

The economic impact of climate change due to the loss in hydropower generation and the increase in electricity demand during late spring and summer is estimated to be approximately $2.7 billion annually in a lower-warming scenario and $6.3 billion annually in a high-warming scenario, with roughly $21 billion in energy assets at risk.[14]

The extent to which climate change will actually affect hydropower generation in California depends both on how precipitation patterns and the amount of warming in different regions end up changing reservoir storage and the flexibility of the systems. Hydropower generation capacity in high-elevation systems peaks in the summer, whereas capacity in lower-elevation systems peaks in winter.[15]

A decreasing Sierra Nevada snowpack (due to a higher snowline and increased temperatures, making more precipitation fall as rain rather than as snow) will also reduce the amount of water available for hydropower generation during late spring and summer when energy demand is higher. The shrinking snowpack will particularly affect high-elevation hydropower systems (higher than 1,000 feet above sea level) that have less storage capacity. This type of system accounts for half of the state's hydropower generation and relies on melting snowpack for operations.[16] In addition, more winter precipitation falling as rain instead of snow will result in extreme flows that will require reservoir operators to release more water, causing undesired spills and retaining less water for the dry months.[17]

Winter storm activities, especially if coinciding with earlier snowmelt and high runoff, can cause flooding which, in turn, can cause damage to transmission lines and lead to power outages. Further research is needed in this area to determine the overall vulnerability of the power grid in coastal and delta areas subject to increased flooding in addition to what recommendations should be implemented.

Lower-elevation hydropower units such as the Central Valley Project (CVP) and the State Water Project (SWP) are expected to generate less power under current climate scenarios, but also require less electricity to pump water to Central and Southern California. When the SWP and CVP power supply and power consumption estimates are combined, the water projects require more energy to operate than they generate. By the end of the century, the amount of supplemental power that the combined projects will need decreases by 500-600 GWh/yr.[18] Both could see reductions in energy production of three percent by mid-century and 6 percent by end of the century.[19]

Changes in precipitation patterns can also be expected to affect other types of infrastructure. For example, sewers and wastewater treatment facilities could see growing strains as climate change proceeds. Expected changes in precipitation patterns include a continued risk of intense rainfall events and associated flooding, with the occasional greater-than-historical flooding events. Such extreme rainfall events and flooding can cause overloading of wastewater systems, as well as physical damage to culverts, canals, and water treatment facilities.

Researchers and the California Department of Transportation also expect increased damage of transportation infrastructure as a result of flooding of tunnels, coastal highways, runways, and railways, and associated business interruptions. The combination of a generally drier climate in the future, which will increase the chance of drought and wildfires, and the occasional extreme downpour, is likely to cause more mud- and landslides which can disrupt major roadways and rail lines. The related debris impacts are historically well known to California, but if they become more frequent, will create greater costs for the state and require more frequent repair.[20]

C. Sea-Level Rise and Extreme Events

Accelerating sea-level rise is likely to cause some of the greatest impacts on California's infrastructure, including vital lines of coastal transportation, possibly some of the power plants located along the coast, a densely developed urban landscape, wastewater treatment facilities, ports, airports, and any other lifelines.

Port infrastructure and airports located near sea level are particularly vulnerable. The San Francisco Bay area for example, is home to three major airports – San Francisco, Oakland, and San Jose – which are all near sea level (Figure 25). Unless these exposed assets are raised and/or protected by seawalls, they will be inundated and will experience increasing flooding as storm surges reach higher and farther inland. Similarly vulnerable are California's seaports, which account for 40 percent of total U.S. shipping volume[21] and have extensive docking facilities at risk. The total value of at-risk air and seaport infrastructure is estimated to total in the multi-billions of dollars.[22] Furthermore, a substantial amount of ground transportation infrastructure, including 2,500 miles of roads and railroads, is projected to be at growing risk from storm-related coastal flooding, elevated due to accelerated sea-level rise.[23] This infrastructure is vital to the residents of California as they commute to work and school, is needed for the movement of commercial freight and thus is integral to the functioning of the overall state economy.

Figure 25: *Projected Sea Level Rise around San Francisco Airport (SFO)*

The economic cost associated with the required alteration, fortification, or relocation of existing infrastructure is likely to be substantial. One example is the proposal by the California Department of Transportation to move three miles of Highway 1 in Big Sur as far as 475 feet inland in order to protect against expected cliff erosion underneath the current stretch of highway.[24] Other infrastructure components that may require modifications include raising bridges to ensure marine vessel clearance, fortification of petroleum facilities with ocean exposure, and gravity-assisted outfalls of wastewater discharge.[25]

Certain types of infrastructure may also be at risk from indirect impacts of climate change and coastal inundation, such as the potential for sea water backflow to impair coastal water sanitation drainage systems during flood events,[26] or the collapse of cliffs, due to increased erosion, that underlie housing developments, roadways, and sewers placed on coastal bluffs. Further, substantial sea-level rise may necessitate entirely new drainage systems in low-lying cities with drainage that is pump-driven rather than gravity-driven.[27]

The extent of needed upgrades to existing infrastructure and the construction of new protective infrastructure will also be influenced by the scope of climate change-induced damage to *natural* coastal protective barriers, i.e., the degree of erosion of beaches, cliffs, and wetlands.[28] Additionally, studies find that protective infrastructure in particular areas may be at risk of heightened dual-sided stress as the incidence and intensity of both of sea-based and land-based waters increasingly act upon these barriers. The Bay-Delta levee system, for example, is exposed to increases in the intensity and coincidence of river flooding-related forces combined with increased sea-level rise-related bayside stress.[29]

As discussed in the Ocean and Coastal Resources chapter, California has already begun to protect its low-lying developments from the sea with construction of many miles of levees, sea walls, bluff-protective structures, and other hard structures. Hardening of the coastline, however, is restricted by coastal law to older structures and to certain emergency situations where essential structures or infrastructure is at risk from immediate loss. However, as sea level continues to rise at a faster pace and coastal storms become more intense due to higher storm surges, existing fortifications will be increasingly inadequate. Not only will existing barriers need to be raised, but new, previously not at-risk sections of coastal and bay-side lands and ecosystems will become at risk.[30] Moreover, both new and old infrastructure will likely require more frequent and costly maintenance should the intensity and duration of water and wind forces increase as projected.

One study conducted for the 2009 California Impacts Assessment found that about $100 billion in structures, contents, and infrastructure along the California coast and San Francisco Bay and Delta may be at risk of storm-related inundation by 2100 due to projected increases in mean sea level. This estimate may be conservative as population growth, development and any contribution to sea level from Greenland and West Antarctic ice sheet melting have not been included (see Chapter 3 on sea-level rise projections).[31] Nearly 300,000 acres of Bay-Delta lands are already below sea level, sit upon continuously subsiding land and rely upon an aging levee system that was built upon soft peat soils.[32] Furthermore, the amount of at-risk development in the Bay area, without accounting for any future development, could more than double from current levels by 2100.[33]

Costs associated with constructing the necessary fortifications of natural barriers and new protective infrastructures are likely to be substantial. A 2008 study estimating the cost of coastal protection structures necessary to safeguard *existing* development against rising sea levels found that 1,070 miles of new or upgraded protective levees and seawalls will be needed by 2100 to protect the Bay and open coastline against inundation under a scenario of ~5 feet (1.4 meter) sea-level rise.[34] Such coastal protection could conservatively involve a capital cost of over $14 billion and will require ongoing maintenance, which may add an additional annual cost of 10 percent of the capital cost.[35] These estimated costs, however, do not consider potential ecological impacts and unintended consequences or armoring coastal areas and legal restrictions for such actions. Therefore, actual adaptation costs could be much higher. The study also found that the burden of construction costs will be disproportionate along California's coast, as Southern California will need the greatest investment, with 20 percent of the capital investment required in Los Angeles County alone.[36] It would be necessary to fortify existing protective infrastructure by 0.1-0.2 feet per year for the next few decades in order to merely keep pace with rising waters and to maintain the same relative risk of flood-related inundation those lands have had in recent years.[37]

POTENTIAL INFRASTRUCTURE IMPACTS DUE TO SEA-LEVEL RISE

- Seaside Airports - Vulnerable to Storm-related Inundation
- Seaports and Docks - Inundation and Flooding (Impedes Business)
- Roads and Railroads - Risk of Storms and Coastal Flooding
- Sea-Level Rise and Coastal Surges Requires Increased Fortifications.
- Economic Costs of Fortifications or Relocation is Considerable
- Sea Water - Floods Can Damage Coastal Water Sanitation Systems Requiring Costly Upgrades
- Sea-Level Rise and river Flooding will Impact Bay-Delta Levee System

D. Changing Risks for Infrastructure

To summarize the changing risks that California's transportation and energy infrastructure may be facing from climate change, the likelihood of occurrence of the projected consequences was qualitatively assessed. The resulting risk profile for California's infrastructure can be characterized as follows:

- Higher average temperatures and higher summer peaks will greatly affect energy production, distribution (transmission), and demand with increased cooling demand likely to far outpace reductions in heating demand in the winter.

- Higher temperatures, together with a drying climate and less snowpack, will decrease the amount of water available for hydropower generation, especially high-elevation systems. In addition, transmission of electricity is less efficient during hotter periods, leading to electricity deficits especially during peak demand times. The risk of outages is likely to increase.

- Temperature extremes can increase the risk of road and railroad tracks buckling, decreasing transportation safety and creating higher maintenance costs.

- More winter precipitation falling as rain instead of snow will result in extreme flows that will require reservoir operators to release more water, causing undesired spills and retaining less water for the dry months.

- Winter storms, especially if coinciding with earlier snowmelt and high runoff, can cause flooding and damage to transmission lines, overloading and damage of wastewater treatment facilities, as well as physical damage to culverts, canals, tunnels, coastal highways, runways, and railways, and associated business interruptions.

- More drought, fires and intense rainfall events will produce more mud- and landslides which can disrupt major roadways and rail lines.

- Sea-level rise is likely to cause the greatest impacts on California's infrastructure, including more frequent storm-related flooding of airports, seaports, roads, and railways in floodplains due to higher sea levels.

- As sea level rises at a faster pace and coastal storm surges increase, existing fortifications will be increasingly inadequate and need to be raised, and areas previously not at-risk will become at risk.

- The economic cost associated with the required alteration, fortification, or relocation of existing infrastructure is likely to be in the tens of billions.

- Sea water backflow will impair coastal water sanitation drainage systems during flood events, requiring costly upgrades and alterations.

- The Bay-Delta levee system, for example, is exposed to increases in the intensity and coincidence of river flooding-related forces combined with increased sea-level rise-related bayside stress.

Infrastructure Adaptation Strategies

Introduction

The state agencies that participated in the Climate Adaptation Working Group (California Energy Commission and California Department of Transportation) developed the following strategies and shall be responsible for and will spearhead strategy implementation. Climate is already changing in California and its impacts are going to be felt in all sectors of the state's economy. The impacts of climate change on infrastructure will vary at the local level, but it is certain they will be widespread and costly in human and economic terms, and will require significant changes in the planning, design, construction, operation, and maintenance of California's infrastructure. Infrastructure adaptation strategies developed thus far pertain to two aspects of development: transportation and energy.

Transportation routes and infrastructure will be dramatically affected by sea-level rise. Therefore, adaptation strategies focus on this effect of climate change. Adaptation plans will be developed for the long-term with estimations of future growth, demand, and vulnerability issues. A 50-year planning horizon will be used to parallel the time period of current model predictions. Predicted sea-level rise and storm surges will be guarded against by increasing the elevation of streets, bridges, and rail lines, while some at-risk sections of roads and rail lines will be relocated farther inland. Flood zones will be re-mapped to account for different sea-level rise projections. As a result of these updated maps, areas may be identified that will need to be returned to a natural state.

Energy infrastructure will be tested by higher temperatures and intense storm events. Adaptation strategies focus on reducing the increase of peak energy demand by developing energy efficiency programs. These programs will promote the use of more efficient air conditioning equipment and lighting systems. They will work to increase the level of insulation (ceiling, floor and walls) and window glazing used in new and existing homes. The planting of trees will be used to shade homes and buildings, and the use of roof materials that reflect the heat to reduce the "heat island effect" will be promoted in new construction. Energy strategies such as smart grid technologies also aim to improve the ability of the electricity system to respond to peak demands. Additionally, they will implement modern techniques for the integrated management of water reservoirs in Northern California to improve their management, and include information regarding changing hydrological patterns in that management.

The impacts of climate change on California's infrastructure are varied and far-reaching. Infrastructure adaptations to climate change will be costly, but it will be more expensive if the state does not begin planning and adapting before the predicted changes alter the physical landscape. California's infrastructure is the conduit through which economic activity flows. The production and movement of goods and services relies on existing infrastructure. Disruption of these deliveries will be detrimental to California's economy. Protection of infrastructure will help ensure California's future as a leading economic player.

Adaptation Strategies and Actions

The California Energy Commission (Energy Commission) and the California Department of Transportation (CalTrans) have identified the following priorities in addressing climate adaptation for California state agencies. The near term actions referenced below are those actions that have been identified and which can be initiated or completed by 2010. The long term actions include those recommended actions that will require support from that state, and collaboration with multiple state agencies.

Climate is already changing in California and its impacts are going to be felt in all sectors of the state's economy. The impacts of climate change on infrastructure will vary at the local level, but it is certain they will be widespread and costly in human and economic terms, and will require significant changes in the planning, design, construction, operation, and maintenance of California's infrastructure. Infrastructure adaptation strategies developed thus far pertain to two aspects of development: transportation and energy.

Strategy 1 - ENERGY
Increase Energy Efficiency Efforts in Climate Vulnerable Areas

<u>Near -Term and Long-Term Actions:</u>

a. **Meet the Energy Efficiency Goals Outlined in AB32 Scoping Plan** – The Air Resources Board's (ARB) Scoping Plan has identified 26.3 MMTCO_2e that will be reduced by 2020 through increased use of building and appliance efficiency standards, increased combined heat and power generation and through increased solar water heating improvements (AB1470). Ensuring these measures are met, while increasing these efforts over time, will help ease projected energy demand increases and possible supply disruptions from climate change.

b. **Facilitate Access to Local, Decentralized Renewable Resources** – The Energy Commission should consider policies and incentives to maximize and to encourage de-centralized (local and near demand) generation and on-site renewable energy generation systems where feasible and appropriate. This deployment of additional renewable generation would reduce GHG gas emissions and help meet the expected increase in electrical demand due to climate change.

Strategy 2 - ENERGY
Assess environmental impacts from climate change in siting and re-licensing of new energy facilities.

<u>Near -Term and Long-Term Actions:</u>

a. **Assess Power Plants Vulnerable to Climate Impacts, and Recommend Reasonable Adaptation Measures** – The Energy Commission will assess GHG impacts for power plant siting cases through its Integrated Energy Policy Report, and consider the potential impact of sea-level rise, temperature increases, precipitation changes and extreme events, where relevant.

b. **Encourage Expansion of Renewable Energy Resources** – The Energy Commission should assess long-term benefits of renewable energy generation in reducing GHG emissions that provide environmental benefits. The state shall encourage additional development of the most suitable and efficient renewable technologies to maximize the amount of electrical generation from renewable sources. The Energy Commission and DFG should encourage renewable energy generation in the least sensitive environmental areas to maintain natural habitats and healthy forests that will further buffer the environmental impacts of climate change.

c. **Assess the Impacts of Climate Change on Energy Infrastructure** – Use the Energy Commission's PIER regional climate modeling and related study efforts to assess the potential impacts of climate change on energy infrastructure from sea-level rise, precipitation, and temperature changes and other impacts. The Energy Commission will determine additional actions on its siting and planning programs based on this work.

d. **Identify the Most Vulnerable Communities** – Develop an energy-use "hot-spot" map to identify areas in the state where increases in temperature, population, and energy-use will make communities most vulnerable to climate change impacts. The Energy Commission will include in this analysis how the lowest-income communities in hot spot areas will be impacted.

Strategy 3 - ENERGY
Develop Hydropower Decision-Support Tools to Better Assess and Manage Climate Change Variability

<u>Near -Term and Long-Term Actions:</u>

a. **Expand Scientific Climate Research** – The Energy Commission and the DWR will continue to support and develop enhancements and demonstration of modern decision support systems for the management of existing major water reservoirs in California to adapt to current levels of climate variability and increase our resilience to increased levels of climate variability and change in the future.

b. **Public Interest Energy Research** – The Energy Commission's PIER program will sponsor research on climate change factors influencing hydropower generation – for example, how hydropower generation would be affected by requirements to release additional water to attenuate increased water temperatures in rivers and streams for environmental purposes.

c. **Develop Partnerships** –Partner with hydropower generators particularly vulnerable to climate change to identify how public-private partnerships could reduce long-term risks to hydropower generation.

Strategy 4 - ENERGY
Identify how state renewable energy goals could be impacted from future climate impacts.

<u>Near -Term and Long-Term Actions:</u>

a. **Assess Climate Impacts on Energy** – The Energy Commission's PIER program will research how climate change impacts could influence the goals of AB32, AB118, and EO S-13-08 goals. For example, climate change will influence wind speeds and patterns, temperature density, etc. that will affect power levels from wind turbines, photovoltaics, etc. In addition, biomass feedstocks could be reduced due to decreased water levels and increased wildfire. It is unclear how this will impact long-term projections for meeting our 2020 and 2050 renewable energy goals.

The near term actions referenced below are those actions that have been identified and which can be initiated by 2010, subject to availability of necessary information to ensure credibility of the analysis and authority of the information, and will require collaboration with multiple state, regional and local agencies. The long term actions include those recommended actions that will require support from the state and collaboration with multiple state, regional, and local agencies.

Strategy 5 - TRANSPORTATION
Develop a detailed climate vulnerability assessment and adaptation plan for California's transportation infrastructure.

<u>Near -Term and Long-Term Actions:</u>

a. **Vulnerability and Adaptation Planning** – BTH (Business, Transportation and Housing Agency) and CALTRANS will develop a climate vulnerability plan that will assess how California's transportation infrastructure facilities are vulnerable to future climate impacts, assess climate adaptation options, prioritize for implementation, and select adaptation strategies to adopt in coordination with stakeholders. This plan will be coordinated with an updated climate mitigation plan that will act as BTH's and Caltrans' overall transportation climate policy.
    i. Develop a transportation use "hot-spot" map – Caltrans will research and identify transportation "hot spots" to identify across the state where the mixture of climate change impacts, population increases, and transportation demand increases will make communities most vulnerable to climate change impacts. Caltrans will include in this analysis how the lowest-income communities in hot spot areas will be impacted.
b. **Economic Impacts Assessment** – Complete an overall economic assessment for projected climate impacts on the state's infrastructure under a "do nothing" scenario and under climate policy scenarios identified by BTH/Caltrans.
    i. Prepare a list of transportation adaptation measures/projects to do another economic analysis either project by project or collectively for programming purposes. This also allows cost/benefit analysis to be used alongside other evaluation criteria when prioritizing adaptation measures and projects.

Strategy 6 - TRANSPORTATION
Incorporate climate change vulnerability assessment planning tools, policies, and strategies into existing transportation and investment decisions.

<u>Near -Term and Long-Term Actions:</u>

a. **Integrate Mitigation and Adaptation System-wide** –Caltrans will develop and incorporate climate change mitigation and adaptation policies and strategies throughout state strategic, system and regional planning efforts. These will be included in key phases of the following planning and project development phases when appropriate:

   i. Strategic Planning (Governor's Strategic Growth Plan and California Transportation Plan)

   ii. System Planning (i.e., District System Management Plan, Inter-regional Strategic Plan, Corridor System Management Plan, and Transportation Concept Report)

   iii. Regional Transportation Planning (Regional Transportation Plan Guidelines and Regional Blueprint Planning)

   iv. Project planning (Project Development Procedures Manual, Project Initiation Document, Project Report, Environmental Guidelines)

   v. Programming (State Transportation Improvement Program, State Highway Operations and Protection Program, California Transportation Commission State Transportation Improvement Program Guidelines)

Strategy 7 - TRANSPORTATION
Develop transportation design and engineering standards to minimize climate change risks to vulnerable transportation infrastructure.

<u>Near-Term and Long Term Actions:</u>

a. **Transportation infrastructure assessment** - Caltrans will assess existing transportation design standards as to their adequacy to withstand climate forces from sea level rise and extreme weather events beyond those considered.

b. **Buffer zone guidelines** - Develop guidelines to establish buffer areas and set backs to avoid risks to structures within projected "high" future sea level rise or flooding inundation zones.

c. **Stormwater quality** - Assess how climate changes could alter size and design requirements for stormwater quality BMP's.

Strategy 8 - TRANSPORTATION
Assess environmental impacts from climate change in rehabilitating the transportation system and siting of new transportation projects.

<u>Near -Term and Long Term Actions:</u>

a. **Vulnerability Assessment** – Assess new transportation project's vulnerability to climate impacts, and recommend reasonable adaptation measures - CALTRANS will assess climate change impacts on system rehabilitation and new, significant siting cases.

b. **Impacts Assessment –** Use updated NAS and other appropriate study efforts to assess the potential impacts of climate change on transportation infrastructure. .

Strategy 9 - TRANSPORTATION
Incorporate climate change impact considerations into disaster preparedness planning for all transportation modes.

Near -Term and Long Term Actions:

a. **Emergency Preparedness** – CALTRANS provides significant emergency preparedness abilities for all transportation modes across the state. The transportation system is sensitive to rapid increases in precipitation, storm severity, wave run-up and other extreme weather events. CALTRANS will assess the type of climate-induced impact information necessary to respond to district emergencies. Results will be incorporated into existing operations management plans.

b. **Decision Support** – CALTRANS will identify how climate impact information can be integrated into existing Intelligent Transportation Systems and Transportation Management Center operations.

Appendix A:

EXECUTIVE ORDER S-13-08

by the Governor of the State of California

WHEREAS climate change in California during the next century is expected to shift precipitation patterns, accelerate sea level rise and increase temperatures, thereby posing a serious threat to California's economy, to the health and welfare of its population and to its natural resources; and

WHEREAS California is a leader in mitigating and reducing its greenhouse gas emissions with the 2006 Global Warming Solutions Act (Assembly Bill 32), the Low Carbon Fuel Standard (Executive Order S-01-07), the 2008 Senate Bill 375 and the Renewable Portfolio Standard; and

WHEREAS these efforts, coupled with others around the world, will slow, but not stop all long-term climate impacts to California; and

WHEREAS California must begin now to adapt and build our resiliency to coming climate changes through a thoughtful and sensible approach with local, regional, state and federal government using the best available science; and

WHEREAS there is a need for statewide consistency in planning for sea level rise; and

WHEREAS California's water supply and coastal resources, including valuable natural habitat areas, are particularly vulnerable to sea level rise over the next century and could suffer devastating consequences if adaptive measures are not taken; and

WHEREAS the country's longest continuously operating gauge of sea level, at Fort Point in San Francisco Bay, recorded a seven-inch rise in sea level over the 20th century thereby demonstrating the vulnerability of infrastructure and resources within the Bay; and

WHEREAS global sea level rise for the next century is projected to rise faster than historical levels with the Intergovernmental Panel on Climate Change predicting that global sea levels will rise by between seven to 23 inches this century and some experts predicting even higher rises; and

WHEREAS while climate models predicting global sea level rise are generally understood and improving, less information is available for sea level rise projections specific to California that accounts for California's topography, coastal erosion rates, varying land subsidence levels and tidal variations; and

WHEREAS billions of dollars in state funding for infrastructure and resource management projects are currently being encumbered in areas that are potentially vulnerable to future sea level rise; and

WHEREAS safety, maintenance and operational efforts on existing infrastructure projects are critical to public safety and the economy of the state; and

WHEREAS the longer that California delays planning and adapting to sea level rise the more expensive and difficult adaptation will be; and

WHEREAS the California Resources Agency is a member of the California Climate Action Team and is leading efforts to develop and implement policy solutions related to climate change adaptation regarding current and projected effects of climate change; and

WHEREAS the Department of Water Resources (DWR) is responsible for managing the state's water resources to benefit the people of California, and to protect, restore and enhance the natural and human environments; and

WHEREAS California's coastal management agencies such as the California Coastal Commission, the California Ocean Protection Council (OPC) and California State Parks are charged with managing and protecting the ocean and coastal resources of the state; and

WHEREAS the California Energy Commission's (CEC) Public Interest Energy Research Program has funded research on climate change since 2001 including funding the development of preliminary sea level rise projections for the San Francisco Bay area by the Scripps Institution of Oceanography/University of California at San Diego.

NOW, THEREFORE, I, ARNOLD SCHWARZENEGGER, Governor of the State of California, by virtue of the power vested in me by the Constitution and statutes of the State of California, do hereby order effective immediately:

1. The California Resources Agency, in cooperation with DWR, CEC, California's coastal management agencies, and the OPC, shall request that the National Academy of Sciences (NAS) convene an independent panel to complete the first California Sea Level Rise Assessment Report and initiate, within 60 days after the signing of this Order, an independent sea level rise science and policy committee made up of state, national and international experts.

2. By March 31, 2009, the OPC, DWR and the CEC, in coordination with other state agencies, shall hold a public workshop to gather policy-relevant information specific to California for use in preparing the Sea Level Rise Assessment Report and to raise state awareness of sea level rise impacts.

3. The California Resources Agency shall request that the final Sea Level Rise Assessment Report be completed as soon as possible but no later than December 1, 2010. The final Sea Level Rise Assessment Report will advise how California should plan for future sea level rise. The report should include: (1) relative sea level rise projections specific to California, taking into account issues such as coastal erosion rates, tidal impacts, El Niño and La Niña events, storm surge and land subsidence rates; (2) the range of uncertainty in selected sea level rise projections; (3) a synthesis of existing information on projected sea level rise impacts to state infrastructure (such as roads, public facilities and beaches), natural areas, and coastal and marine ecosystems; and (4) a discussion of future research needs regarding sea level rise for California.

4. The OPC shall work with DWR, the CEC, California's coastal management agencies and the State Water Resources Control Board to conduct a review of the NAS assessment every two years or as necessary.

5. I direct that, prior to release of the final Sea Level Rise Assessment Report from the NAS, all state agencies within my administration that are planning construction projects in areas vulnerable to future sea level rise shall, for the purposes of planning, consider a range of sea level rise scenarios for the years 2050 and 2100 in order to assess project vulnerability and, to the extent feasible, reduce expected risks and increase resiliency to sea level rise. However, all projects that have filed a Notice of Preparation, and/or are programmed for construction funding the next five years, or are routine maintenance projects as of the date of this Order may, but are not required to, account for these planning guidelines. Sea level rise estimates should also be used in conjunction with appropriate local information regarding local uplift and subsidence, coastal erosion rates, predicted higher high water levels, storm surge and storm wave data.

6. The Business, Transportation, and Housing Agency shall work with the California Resources Agency and the Governor's Office of Planning and Research (OPR) to prepare a report within 90 days of release

of this Order to assess vulnerability of transportation systems to sea level rise that will include provisions for investment critical to safety, maintenance and operational improvements of the system and economy of the state.

7. By June 30, 2009, the California Resources Agency, through the Climate Action Team, shall coordinate with local, regional, state and federal public and private entities to develop a state Climate Adaptation Strategy. The strategy will summarize the best known science on climate change impacts to California (led by CEC's PIER program), assess California's vulnerability to the identified impacts and then outline solutions that can be implemented within and across state agencies to promote resiliency. A water adaptation strategy will be coordinated by DWR with input from the State Water Resources Control Board, an ocean and coastal resources adaptation strategy will be coordinated by the OPC, an infrastructure adaptation strategy will be coordinated by the California Department of Transportation, a biodiversity adaptation strategy will be jointly coordinated by the California Department of Fish and Game and California State Parks, a working landscapes adaptation strategy will be jointly coordinated by the California Department of Forestry and Fire Protection and the California Department of Food and Agriculture, and a public health adaptation strategy will be jointly coordinated by the California Department of Public Health and the California Air Resources Board, all as part of the larger strategy. This strategy will be facilitated through the Climate Action Team and will be coordinated with California's climate change mitigation efforts.

8. By May 30, 2009, OPR, in cooperation with the California Resources Agency, shall provide state land-use planning guidance related to sea level rise and other climate change impacts.

This Order is not intended to, and does not, create any rights or benefits, substantive or procedural, enforceable at law or in equity, against the State of California, its agencies, departments, entities, officers, employees, or any other person.

I FURTHER DIRECT that as soon as hereafter possible, this Order shall be filed with the Office of the Secretary of State and that widespread publicity and notice be given to this Order.

IN WITNESS WHEREOF I have hereunto set my hand and caused the Great Seal of the State of California to be affixed this 14th day of November 2008.

ARNOLD SCHWARZENEGGER
Governor of California

Appendix B: Glossary

Key Climate Change Adaptation Concepts and Terms

The following terms were collected from the *Intergovernmental Panel on Climate Change Third Assessment Report* (2001), unless otherwise noted.

Adaptation – Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which minimizes harm or takes advantage of beneficial opportunities.

Adaptation Assessment – The practice of identifying options to adapt to climate change and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency, and feasibility.

Adaptation Benefits – The avoided damages (measured in monetary terms or otherwise) or the accrued benefits following the adoption and implementation of adaptation measures.

Adaptation Costs – Costs of planning, preparing for, facilitating, and implementing adaptation measures, including transition costs and unavoidable negative side effects.

Adaptive Capacity – The ability of a system to respond to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, and to cope with the consequences.[3]

Adaptation Policy Framework – is a structural process for developing adaptation strategies, policies, and measures to enhance and ensure human development in the face of climate change, including climate variability. It consists of five basic components: assessing current vulnerability, characterizing future climate risks, developing an adaptation strategy, scoping and designing individual adaptation projects to implement the strategy, monitoring results, adjustments, and continuing the adaptation process.[4]

Baseline/Reference – The baseline (or reference) is any datum against which change is measured. It might be a "current baseline," in which case it represents observable, present-day conditions. It might also be a "future baseline", which is a projected future set of conditions excluding the driving factor of interest (e.g., how would a sector evolve without climate warming). It is critical to be aware of what change is measured against which baseline to ensure proper interpretation. Alternative interpretations of the reference conditions can give rise to multiple baselines.[6]

Climate Change – Climate change refers to any long-term change in average climate conditions in a place or region, whether due to natural causes or as a result of human activity.

(Climate) Impacts Assessment – The practice of identifying and evaluating the detrimental and beneficial consequences of climate change on natural and human systems.

(Climate Change) Impacts – Consequences of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts.

Climate Variability – Climate variability refers to variations in the mean state of the climate and other statistics (such as standard deviations, the occurrence of extremes, etc.) on all temporal and spatial scales beyond that of individual weather events.

Co-benefits – The benefits of policies that are implemented for various reasons at the same time—including climate change mitigation—acknowledging that most policies designed to address greenhouse gas mitigation also have other, often at least equally important, rationales (e.g., related to objectives of development, sustainability, and equity).

Impact – An effect of climate change on the structure or function of a system.[2]

Integrated Assessment – A method of analysis that combines results and models from the physical, biological, economic, and social sciences, and the interactions between these components, in a consistent framework to evaluate the status and the consequences of environmental change and the policy responses to it.

Mitigation – A human intervention to reduce the sources or improve the uptake (sinks) of greenhouse gases.

No-regrets policy – A policy that would generate net social benefits whether or not there is climate change.

Policies and Measures – Usually addressed together, respond to the need for climate adaptation in distinct, but sometimes overlapping ways. Policies, generally speaking, refer to objectives, together with the means of implementation. Measures can be individual interventions or they consist of packages of related measures.[4]

Potential Impacts – All impacts that may occur given a projected change in climate, without considering adaptation.

Residual Impacts –The impacts of climate change that would occur after adaptation.

Resilience – The ability of a system to absorb some amount of change, including shocks from extreme events, bounce back and recover from them, and, if necessary, transform itself in order to continue to be able to function and provide essential services and amenities that it has evolved or been designed to provide.*

*It is important to note that resilience, as the term applies to ecosystems, is being used as a way to measure a systems ability to recover from stress or disturbance without undergoing a fundamental change in process or structure with the recognition that climate change will likely not allow for the return to a pre-existing equilibrium as the definition of resilience implies[7].

Risk (climate-related) – is the possibility of interaction of physically defined hazards with the exposed systems. Risk is commonly considered to be the combination of the likelihood of an event and its consequences – i.e., risk equals the probability of climate hazard occurring multiplied the consequences a given system may experience.[4]

Sensitivity – The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., climatic or non-climatic stressors may cause people to be more sensitive to additional extreme conditions from climate change than they would be in the absence of these stressors).

System – A human population or ecosystem; or a group of natural resources, species, infrastructure, or other assets.

Vulnerability – In the most general sense, a susceptibility to harm or change. More specifically, the degree to which a system is exposed to, susceptible to, and unable to cope with, the adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, as well as of non-climatic characteristics of the system, including its sensitivity, and its coping and adaptive capacity.

Vulnerability Assessment – A practice that identifies who and what is exposed and sensitive to change and how able a given system is to cope with extremes and change. A vulnerability assessment considers the factors that expose and make people or the environment susceptible to harm and accesses to natural and financial resources available to cope and adapt, including the ability to self-protect, external coping mechanisms, support networks, and so on.[5]

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Appendix C: Acronyms

Acronyms used in the California Climate Adaptation Strategy

ACE- Areas of Conservation Emphasis (defined by the Department of Fish and Game)

ARB- Air Resources Board

BLM- Bureau of Land Management

BIA- Bureau of Indian Affairs

BMPs- Best Management Practices

BOF- Board of Forestry and Fire Protection

BTH- Business, Transportation and Housing Agency

CalEMA- California Emergency Management Agency

Cal/EPA- California Environmental Protection Agency

Cal/Fire, CAL FIRE - California Department of Forestry and Fire Protection

Cal-REDIE- California Reportable Disease Information Exchange

CalTrans- California Department of Transportation

CALVIN- California Value Integrated Network

CAS- California Climate Adaptation Strategy

CAT- Climate Action Team

CAWGS- Climate Adaptation Working Groups

CBC- California Biomass Collaborative

CCAPA- California Chapter of the American Planning Association CCVA- California Climate Vulnerability Assessment

CCVA- California Climate Vulnerability Assessment

CDFA- California Department of Food and Agriculture

CDPH- California Department of Public Health

CEC- California Energy Commission

CERES- California Environmental Resources Evaluation System

CEQA- California Environmental Quality Act

CFIP- California Forest Improvement Program

CIMIS- California Irrigation Management Information System

CISC- California Invasive Species Council

CNRA- California Natural Resources Agency

COGs- Councils of Government

CSMP - Corridor System Management Plan

CTC STIP guidelines - California Transportation Commission State Transportation Improvement Program guidelines

CVP- Central Valley Project

DFG- Department of Fish and Game

DOC- Department of Conservation

DPR-Department of Parks and Recreation

DSMP - District System Management Plan

DWR- Department of Water Resources

EIR- Environmental Impact Report

ENSO- El Niño Southern Oscillation

EO- Executive Order

EPA- Environmental Protection Agency

EWMPs- Efficient Water Management Practices

FEMA- Federal Emergency Management Agency

FRAP- Fire and Resource Assessment Program

GHG- Green House Gases

ICLEI- Local Governments for Sustainability

IPCC- Intergovernmental Panel on Climate Change

IRWM- Integrated Regional Water Management

ITSP - Interregional Transportation Strategic Plan

JOC- Joint Operations Center

LCP- Local Coastal Plan

MPOs- Metropolitan Planning Organizations

NAS- National Academy of Science

NFIP- National Flood Insurance Program

NFW- National Fish and Wildlife Foundation

NGO- Non-Governmental Organizations

NPS- National Park Service

NRC- National Research Council

NRCS- Natural Resource Conservation Service

OPC- Ocean Protection Council

OPR- Governor's Office of Planning and Research

PDPM - Project Development Procedures Manual

PID - Project Initiation Document

PIER- Public Interest Environmental Research Program (run through the California Energy Commission)

PR - Project Report

RCD- Resource Conservation District

RPS- Renewable Portfolio Standard

SEMS- Standardized Emergency Management System

SFM- State Fire Marshall

SGC- Strategic Growth Council

SHOPP - State Highway Operations and Protection Program

SMUD- Sacramento Municipal Utility District

STIP - State Transportation Improvement Program

SWRCB- State Water Resources Control Board

SWP- State Water Project

TCR - Transportation Concept Report

TNC- The Nature Conservancy

TPZ- Timberland Production Zone, UC- University of California

UCCE- University of California Cooperative Extension

USDA- United States Department of Agriculture

USFS- United States Forest Service

USGS- United States Geological Survey

WCB- Wildlife Conservation Board

WebCMR- Web Portal for the Confidential Morbidity Report

WIC- Women, Infants, and Children Nutrition Program

WNV- West Nile Virus

WUI- Wildland Urban Interface

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Figure 3: Photo courtesy of CalFIRE

Figure 4: Louise Bedsworth and Ellen Hanak. *Preparing California for a Changing Climate*, Public Policy Insititute of California, 2008.

Figure 5: Moser, Susan, Guido Franco, Sarah Pittiglio, Wendy Chou, Dan Cayac (2009). *The Future is Now: An Update on Calimat Change Science, Impact, and Response Options for California.* Prepared for the California Energy Commission, PIER. CEC-500-2008-071

Figure 6: Cayan, et al 2008.

Figure 7: Cayan, et al 2008.

Figure 8: Mastrandrea, Michael D., Claudia Tebaldi, Carolyn P. Snyder, Stephen H. Schneider (2009). *Current and Future Impacts of Extreme Events in California*. PIER Research Report, CEC-500-2009-026-D, Sacramento, CA: California Energy Commission.

Figure 9: Mastrandrea, et al 2009.

Figure 10: IPCC, 2007: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 976pp.

Figure 11: CAL FIRE (2008). *Fire Threat Map*, CAL FIRE Fire and Resource Assessment Program. <http://frap.cdf.ca.gov/data/frapgismaps/download.asp>.

Figure 13: Kahrl, F. and D. Roland-Holst (2008). *California Climate Risk and Response*. Berkeley, CA: University of California-Berkeley, Department of Agricultural and Resource Economics.

Figure 14: Using Mid-Century Climate Projections to Support Water Resources Decision Making in California

Figure 15: Cayan, Dan, Amy Luers, Michael Hanneman, Guido Franco, Bart Cross (2006). *Scenarios of Climate Change in California: an Overview.* California Climate Change Center White Paper, CEC-500-2005-186-SF.

Figure 17: Lobell, David, Christopher B. Field (2009). *California Perennial Crops in a Changing Climate.* California Climate Change Center. CEC-500-2009-039-D.

Figure 18: Lee, Juhwan, Steven De Gryze Johan Six (2009). *Effect of Climate Change on Field Crop Production in the Central Valley of California.* California Climate Change Center. CEC-500-2009-041-D.

Figure 21: Leurs, et al 2006.

Figure 22: Aroonruengsawat, Anin, Maximilian Auffhammer (2009). *Impacts of Climate Change on Residential Electricity Consumption: Evidence from Billing Data*. California Climate Change Center, CEC-500-2009-018-D.

Figure 23: Cayan, et al 2006.

Figure 25: Projected Sea Level Rise around San Francisco Airport (SFO), prepared by the San Francisco Bay Conservation and Development Commission, 2009.

California Photovoltaic Installations
Compound Annual Growth Model

generation rate (dc):	1425	kwh/kw-yr
ac capacity-derate:	85%	
generation rate (ac):	1676	kwh/kw-yr
capacity factor	19.1%	
energy target:	40,000	gigawatt hours
capacity	23,860	megawatts

growth rate per year:		**50%**			**40%**	
yft	year	annual megawatts	cumulative megawatts	generation gigawatt-hrs	annual megawatts	cumulative megawatts
	2009	200	500	838	200	500
	2010	300	800	1,341	280	780
1	2011	450	1,250	2,096	392	1,172
2	2012	675	1,925	3,227	549	1,721
3	2013	1,013	2,938	4,925	768	2,489
4	2014	1,519	4,456	7,471	1,076	3,565
5	2015	2,278	6,734	11,290	1,506	5,071
6	2016	3,417	10,152	17,019	2,108	7,179
7	2017	5,126	15,277	25,612	2,952	10,131
8	2018	7,689	22,966	38,502	4,132	14,263
9	2019	**11,533**	**34,499**	**57,837**	5,785	20,048
10	2020	17,300	51,799	86,839	**8,099**	**28,147**
11	2021	25,949	77,748	130,342	11,339	39,486
12	2022	38,924	116,672	195,597	15,874	55,360
13	2023	58,386	175,058	293,479	22,224	77,584
14	2024	**87,579**	**262,636**	**440,302**	31,114	108,698
15	2025				43,559	152,257
16	2026				**60,983**	**213,239**
17	2027					
18	2028					
19	2029					
20	2030					
21	2031					
22	2032					
23	2033					
24	2034					
25	2035					
26	2036					
27	2037					
28	2038					
29	2039					
30	2040					
31	2041					
32	2042					
33	2043					

34	2044
35	2045
36	2046
37	2047
38	2048
39	2049
40	2050
41	2051
42	2052
43	2053
44	2054
45	2055
46	2056
47	2057
48	2058
49	2059
50	2060

	30%			20%		
generation gigawatt-hrs	annual megawatts	cumulative megawatts	generation gigawatt-hrs	annual megawatts	cumulative megawatts	generation gigawatt-hrs
838	200	500	838	200	500	838
1,308	260	760	1,274	240	740	1,241
1,965	338	1,098	1,841	288	1,028	1,723
2,885	439	1,537	2,577	346	1,374	2,303
4,173	571	2,109	3,535	415	1,788	2,998
5,976	743	2,851	4,780	498	2,286	3,832
8,501	965	3,817	6,398	597	2,883	4,834
12,035	1,255	5,072	8,502	717	3,600	6,035
16,984	1,631	6,703	11,237	860	4,460	7,477
23,911	2,121	8,824	14,793	1,032	5,492	9,207
33,610	2,757	11,581	19,415	1,238	6,730	11,283
47,188	3,584	15,165	25,424	1,486	8,216	13,774
66,197	4,660	19,825	33,236	1,783	9,999	16,764
92,809	**6,058**	**25,883**	**43,391**	2,140	12,139	20,351
130,067	7,875	33,757	56,593	2,568	14,707	24,656
182,228	10,237	43,994	73,755	3,081	17,788	29,822
255,254	13,308	57,303	96,066	3,698	21,486	36,021
357,490	17,301	74,604	125,071	**4,437**	**25,923**	**43,460**
	22,491	97,095	162,776	5,325	31,248	52,386
	29,238	126,333	211,794	6,390	37,638	63,098
	38,010	164,343	275,516	7,668	45,305	75,953
	49,413	213,756	358,356	9,201	54,506	91,378
	64,237	**277,993**	**466,047**	11,041	65,547	109,888
				13,249	78,797	132,101
				15,899	94,696	158,755
				19,079	113,775	190,741
				22,895	136,671	229,124
				27,474	164,145	275,184
				32,969	197,114	330,455
				39,563	236,676	396,781
				47,475	**284,152**	**476,372**

10%		
annual megawatts	cumulative megawatts	generation gigawatt-hrs
200	500	838
220	720	1,207
242	962	1,613
266	1,228	2,059
293	1,521	2,550
322	1,843	3,090
354	2,197	3,684
390	2,587	4,337
429	3,016	5,056
472	3,487	5,847
519	4,006	6,716
571	4,577	7,673
628	5,205	8,725
690	5,895	9,883
759	6,654	11,156
835	7,490	12,557
919	8,409	14,097
1,011	9,420	15,792
1,112	10,532	17,656
1,223	11,755	19,707
1,345	13,100	21,963
1,480	14,581	24,444
1,628	16,209	27,173
1,791	17,999	30,176
1,970	19,969	33,478
2,167	22,136	37,111
2,384	**24,520**	**41,107**
2,622	27,142	45,503
2,884	30,026	50,338
3,173	33,199	55,657
3,490	36,689	61,508
3,839	40,528	67,943
4,223	44,750	75,023
4,645	49,395	82,810
5,110	54,505	91,376

5,620	60,125	100,798
6,183	66,308	111,163
6,801	73,109	122,565
7,481	80,590	135,106
8,229	88,819	148,902
9,052	97,870	164,077
9,957	107,827	180,769
10,953	118,780	199,131
12,048	130,828	219,330
13,253	144,081	241,548
14,578	158,659	265,987
16,036	174,695	292,871
17,639	192,334	322,443
19,403	211,738	354,972
21,344	233,082	390,755
23,478	256,560	430,115
25,826	282,386	473,412
28,409	**310,794**	**521,038**

THE WHITE HOUSE

WASHINGTON

May 10, 2000

Mr. David Myers
Executive Director
The Wildlands Conservancy
3961 Oak Glen Road
Yucaipa, California 92399

Dear David:

I want to thank you and The Wildlands Conservancy for donating land to the United States for inclusion in Joshua Tree National Park. Your donation of more than 14,000 acres will help protect and preserve fragile desert resources and provide the American people with additional natural areas to treasure and enjoy.

I deeply appreciate your efforts to protect sensitive lands in the California Desert for the National Park Service and Bureau of Land Management. I assure you that my Administration will work to protect and manage the donated lands.

Please convey my appreciation to the Conservancy's Board of Directors, staff, donors, and supporters for this historic donation and all of your work to acquire additional lands for permanent protection.

Sincerely,

Bill Clinton

THE WHITE HOUSE

Office of the Vice President

For Immediate Release | **Contact:**
Thursday, May 18, 2000 | **(202) 456-7035**

VICE PRESIDENT GORE ANNOUNCES NEW LAND PROTECTIONS IN CALIFORNIA DESERT

Calls on Congress to Pass Administration's Lands Legacy Initiative

Washington, DC -- Vice President Al Gore announced today that the Administration and a non-profit conservation organization have secured the money needed to complete a historic acquisition of pristine desert lands in Southern California. The Vice President also called on Congress to support the Administration's Lands Legacy initiative, which includes funding to protect nearby lands from future development.

Under the funding package announced today, the National Park Service (NPS) and the Bureau of Land Management (BLM) will acquire 180,605 acres within and adjacent to federally protected lands between Barstow and Needles. The land will be purchased from the Catellus Development Corporation with $5 million in federal funds secured by the Administration in the fiscal year 2000 budget and a $15 million donation from The Wildlands Conservancy.

"These stunning California Desert lands are being preserved for future generations through a true public-private team effort that could serve as a model in other areas," said Vice President Gore. "I commend the Wildlands Conservancy for its hard work and generosity. Protecting magnificent lands through this type of partnership is a central goal of our Lands Legacy initiative."

The purchase, to be completed within the next month, builds on the California Desert Protection Act signed by President Clinton in 1994. The Act, sponsored by Senator Dianne Feinstein, provided new or enhanced protection for 6.6 million acres, including the new Mojave National Preserve and 69 BLM wilderness areas.

Under an agreement in principle announced in December 1998, Catellus agreed to transfer to the federal government a total of 405,000 acres within and around the lands protected by the 1994 Act. Although the lands were valued at $61.6 million, Catellus agreed to a purchase price of $45 million. The first phase of the acquisition was completed earlier this year with $10 million in federal funds and $15 million from the Wildlands Conservancy. Today's announcement sets the stage for completing the second and final phase of the acquisition.

The areas to be protected include some of the most pristine and scenic desert lands in the world. Their features include cinder cones and lava flows, spectacular ranges of rock and flowing sand dunes, vast valleys, intriguing cactus gardens and important habitat for the endangered Desert Tortoise. Approximately 83,000 acres will be acquired by the Park Service within the Mojave National Preserve, and the Bureau of Land Management will acquire approximately 97,000 acres, including lands in six designated wilderness areas – Clipper Mountains, Dead Mountains, Piute Mountains, Bristol Mountains, Old Woman Mountains and the Chemehuevi Mountains wilderness.

The Vice President commended Senator Feinstein for her leadership in securing the federal funds; The Wildlands Conservancy for its generous donation; and Catellus for selling the land at a substantially discounted price.

The Administration's proposed fiscal year 2001 budget included $15 million to complete the second phase of the acquisition. In light of The Wildlands Conservancy donation, the Administration yesterday proposed redirecting the proposed fiscal year 2001 funding to acquire other critical California desert lands on a willing-seller basis.

Unfortunately, Congress' budget failed to provide funding for the President's Lands Legacy Initiative. As a result, the House Interior Appropriations Subcommittee yesterday could only provide a small portion of needed land acquisition funding, with no funding to acquire critical desert lands. "I am deeply disappointed that Congress is slashing funds that would allow us to forge other partnerships like this one to protect critical lands across America," the Vice President said. "I urge Congress to provide permanent and full funding for Lands Legacy so we can provide states and communities the resources they need to protect their precious green spaces."

Today's acquisition completes the largest purchase of private land in California's history and the largest purchase of land from one seller by the Bureau of Land Management in its 50-year history. Once acquired, the lands would be open to public access for outdoor recreation including hiking, hunting and other permitted uses.

Additional details are available on The Wildlands Conservancy website: *www.wildlandsconservancy.org*

###

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Washington, D.C. 20240
http://www.blm.gov

OCT 3 0 2000

David Myers
Wildlands Conservancy
39611 Oak Glen Road
Yucaipa, CA 92399

Dear Mr. Myers:

It is truly an honor to present you, representing the board of The Wildlands Conservancy, the Bureau of Land Management's (BLM) national Legacy of the Land Award.

The Conservancy, a relatively young organization, has very quickly earned a national reputation for protecting magnificent lands through unprecedented public-private partnerships.

Most notable is the recent completion of the year-and-half-long effort to protect more than 405,000 acres of checkerboard railroad lands, formerly owned by Catellus Corporation, in what Vice President Al Gore called "an historic acquisition of pristine lands in Southern California."

Through the Conservancy's efforts, the BLM and the National Park Service now own critical inholdings in what the Vice President called "some of the most pristine and scenic desert lands in the world." In addition to scenic lands in the Park Service's Mojave National Preserve, BLM was also able to acquire 322,500 acres in 10 designated Wilderness Areas, almost a dozen sensitive wildlife habitat areas, and several key recreational access areas.

These areas are part of spectacular mountain ranges, with unique geological formations, including mountainous landscapes, sweeping bajadas and flowing sand dunes. They contain habitat for a number of threatened and endangered species, including bighorn sheep and desert tortoise. Without the Conservancy's innovation and leadership, these lands could have been developed or sold into private ownership, which would have had far-reaching implications to the surrounding wilderness and wildlife habitat areas.

While this is a tremendous accomplishment, California's diverse but threatened landscapes need further efforts from BLM and the Conservancy. BLM looks forward to a long and productive relationship with you and your talented and generous board. This award is in recognition of both the accomplishment and the future legacy to come.

Sincerely,

Tom A. Fry
Director
Bureau of Land Management

DIANNE FEINSTEIN
CALIFORNIA

COMMITTEE ON FOREIGN RELATIONS
COMMITTEE ON THE JUDICIARY
COMMITTEE ON RULES AND ADMINISTRATION

United States Senate
WASHINGTON, DC 20510-0504
(202) 224-3841

December 10, 1998

The Honorable William Jefferson Clinton
President of the United States
The White House
1600 Pennsylvania Avenue, N.W.
Washington, D.C. 20500

Dear Mr. President:

I am writing to urge you to include $36 million for land acquisition in the California Desert in your fiscal year 2000 budget request. This funding would allow completion of a landmark bid by the Wildlands Conservancy to permanently protect up to 475,000 acres of inholdings in the California Desert's national parks and wilderness areas. Protecting these areas is vital to preserving the unique character and public accessibility of the California Desert.

As you know, I fought to ensure passage of the Desert Protection Act, which you signed into law in 1994. The Desert Protection Act created two new national parks, a national preserve, and over 100 new wilderness areas. Unfortunately, our work is not done. Hundreds of thousands of acres of inholdings in the Desert remain unprotected. Many of these inholdings are in a "checkerboard" pattern, strategically located so that the land effectively blocks access to public lands. Owners of the inholdings, including the Catellus corporation, are making plans to develop their land. This would compromise the California Desert's fragile ecosystem and severely limit recreation opportunities on Federal land.

The Wildlands Conservancy has developed an innovative plan to purchase these inholdings and transfer them to Federal ownership, protecting them permanently from development. The Conservancy proposes to use a combination of Federal and private funds to acquire 475,000 acres of inholdings, mostly owned by Catellus. The Conservancy has pledged $16 million in private funds for the effort. I strongly believe that the Federal government should provide the remaining $36 million to complete this acquisition.

The National Park Service and U.S. Bureau of Land Management are already on record supporting the Wildlands Conservancy proposal. In an interview with the Los Angeles Times, Park Service Regional Director John Reynolds said, "The Wildlands Conservancy effort is ambitious and dramatic. It will be a great day for the Desert."

Moreover, in a letter dated November 24, U.S. Bureau of Land Management State Director Ed Hastey wrote, "Clearly, the reality of the situation in the California Desert with the checkerboard Catellus lands calls for a public/private partnership to leverage your contributions more effectively. The Wildlands Conservancy's pledge of more than $16 million in cash and land...to hopefully be matched with appropriations from the Federal Land and Water Conservation Fund, will give the California Desert the national attention this region deserves. BLM-California will do all it can to support your innovative and bold initiative."

Attached are two letters from The Wildlands Conservancy that explain this proposal in more detail. The Wildlands Conservancy land acquisition proposal will protect endangered species habitat, keep the Desert ecosystem intact, and improve recreation opportunities for millions of Americans. As a member of the Interior Appropriations Subcommittee, I intend to make the Wildlands Conservancy acquisition one of my top environmental priorities in the next Congress. I do hope that I can count on your support and assistance. Please take an important first step by including $36 million for the acquisition in your budget request.

Thank you so much for your attention to this important matter. Please let me know what you decide. If you have any questions or require further information, please do not hesitate to get in touch, or have your staff contact Kathy Reich in my office at (202) 224-3841.

May I take this opportunity to wish you and your family a happy and healthy holiday season.

With warmest personal regards.

Sincerely yours,

Dianne Feinstein
United States Senator

DF:kdr

NEWS

U.S. DEPARTMENT OF THE INTERIOR

Office of the Secretary
For Immediate Release
Jan. 15, 1999

Contact: Tim Ahern, (202)-208-5089
Jan Bedrosian, (916)-978-4616
Holly Bundock, (415)-427-1320

***** <u>MEDIA ADVISORY</u> *****

Babbitt Will Kick Off Mojave Acquisition, Largest Land Deal in California History

Secretary of the Interior Bruce Babbitt will go to the Palm Springs area of Southern California on Wednesday, Jan. 20, to take title to the first 10,000 acres of private lands in the California Desert that will be acquired by the federal government as part of President Clinton's Lands Legacy Initiative.

Almost 500,000 acres of private lands will be acquired through an unprecedented match of private and public funds. The $36 million in federal money will come from the Land and Water Conservation Fund while $25.5 million in private funds is being contributed by The Wildlands Conservancy, a non-profit organization based in Oak Glen, Calif.

"This is an incredible opportunity to preserve a half-million acres of private land which has been interspersed among the new National Parks created by the California Desert Protection Act of 1994," Babbitt said.

On Jan. 20, The Wildlands Conservancy will give Babbitt title to some of the land it has already acquired in the area, including parcels in the San Gorgonio Wilderness, managed by the Bureau of Land Management, and Joshua Tree National Park.

Most of the land to be acquired is owned by the Catellus Development Corp., formerly the land-holding arm of the railroads. The rest of the land is owned by a variety of persons.

Who: Bruce Babbitt, Secretary of the Interior; and other federal officials and representatives of landowners and local and conservation interests

What: The federal government will take title to the first 10,000 acres of land, of a total of about 500,000 acres, that will be acquired in the California desert

When: 12:30 p.m. PST, Wednesday, Jan. 20, 1999

Where: Visitor center at the Santa Rosa Mountains National Scenic Area
51-500 California route 74, Palm Desert, California
(Map to event site is attached)

Contact: Tim Ahern, 202-208-5089 (Department of Interior)
Jan Bedrosian, 916-978-4614 or Carole Levitzky (Bureau of Land Management, California)
Holly Bundock, 415-427-1320 (National Park Service)
David Myers, 909-797-8507 (The Wildlands Conservancy)
John Bezzant, 213-473-3102 (Catellus Corp.)

-DOI-

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
California State Office
2800 Cottage Way, Suite W1834
Sacramento, CA 95825-1886
www.ca.blm.gov

AUG 9 2000

David Myers
Executive Director
The Wildlands Conservancy
39611 Oak Glen Road
Yucaipa, CA 92399

Dear David:

On behalf the Bureau of Land Management, and especially all of us here in California, I would like to officially thank you, the Board of Directors of The Wildlands Conservancy, and your many generous donors for the tremendous achievement of completing the acquisition of Catellus lands in the California Desert recently.

It is an incredible success story and demonstrates the "big picture" vision of the Conservancy, which you so ably lead. At every obstacle, a path to the final goal was found. As a consequence, the public now enjoys ownership of the 405,000 acres the conservancy helped BLM and the Park Service acquire. Present and future generations will benefit greatly, as will the land itself and its wildlife resources.

Your ability to develop alliances and pool resources was truly the essence of what made this achievement possible. BLM will take very good care of these newest public lands and we look forward to a long-term relationship with you and the Conservancy.

Sincerely,

Al Wright

Al Wright
Acting State Director

DAVID -
MY UNQUALIFIED
THANKS FROM US
AT BLM AND
THE PUBLIC -
Al

ALLUVIAL FAN TASK FORCE

Findings and Recommendations Report



APRIL 2010

Inside Front Cover

Photo illustration and cover design by Gigi Hanna, Water Resources Institute
Top Photo: Alluvial fan near the Santa Rosa Mountains, San Diego County, 2009, by Jeremy Lancaster, California Geological Survey
Middle Photo: Alluvial fan near the Little San Bernardino Mountains, Riverside County, 2009, by Jeremy Lancaster, California Geological Survey
Bottom Photo: Development near Caliente Springs, San Diego County, 2009, Google Earth image

All chapter cover photos courtesy Jeremy Lancaster, California Geological Survey
Executive Summary cover photo: Alluvial fan near Santa Rosa Mountains, San Diego County, 2009
Chapter One cover photo: Little San Bernardino Mountains, Riverside County, 2009
Chapter Two cover photo: Area near 29 Palms, San Bernardino County, 2009
Chapter Three cover photo: Toro Canyon alluvial fan, Riverside County, 2009

Placeholder for letter from Alluvial Fan Task Force Chair to DWR

Alluvial Fan Task Force Membership List

Elected Officials	Representing
Supervisor Paul Biane	San Bernardino County
Supervisor Marion Ashley	Riverside County
Supervisor Jon McQuiston	Kern County
Supervisor Bill Horn	San Diego County
Supervisor Michael Antonovich	Los Angeles County
Local Flood Managers	**Representing**
Mike Fox	San Bernardino County Flood Control District
Rick Iger	Kern County Water Agency
Sara Agahi	San Diego County Department of Public Works
Georgia Celehar-Bauer	Coachella Valley Water District
Dusty Williams	Riverside County Flood Control/Water Conservation District
Christopher Stone	Los Angeles County Department of Public Works
Development Community	**Representing**
Ali Sahabi	SE Corporation
Paul Quill	Innovative Land Concepts
Dave Mlynarski	MAPCO
Dale Casey	Standard Pacific Homes
Mark Grey	Building Industry Association of Southern California
Tom Davis	Agua Caliente Band of Cahuilla Indians
Environmental Community	**Representing**
Duane Young	D. Young and Sons (agriculture)
Tom Scott	Riverside Land Conservancy
Joan Taylor	Coachella Valley Mountains Conservancy
Dr. Norman Meek	CSU Professor of Geography and Environmental Studies
Dr. Stephanie Pincetl	UCLA Urban Center for People and the Environment
At Large Members	**Representing**
Mark Pisano	Senior Fellow, USC School of Policy, Planning & Development
Kathleen Webb	Office of the Insurance Commissioner
Tom O'Keefe	California Department of Forestry and Fire Protection
Marty Teal	Floodplain Management Association
Ralph Wagner	San Bernardino County Flood Control District Commission
Eric Shamp	American Institute of Architects
Scott Steinmetz, P.E.	Fireman's Fund Insurance
Lee Reeder	Santa Ana Watershed Association
John McCarthy	Consulting Engineers and Land Surveyors of CA

Alluvial Fan Task Force
Management Team and Technical Consultants

Department of Water Resources	Ricardo Pineda, P.E., C.F.M. Maria Lorenzo-Lee, P.E. Allan Oto Dr. Senarath Ekanakaya, PhD, P.E. Susan Woolam, C.F.M. Steve Cowdin, C.F.M. Stefan Lorenzato
Exponent®, Inc	Doug Hamilton, P.E. Massoud Rezakhani, P.E. Pravi Shrestha, Ph.D., P.E., D.WRE Kristina Cydzik, P.E., LEED AP
FEMA Region IX	Raymond T. Lenaburg
U.S. Army Corps of Engineers Institute for Water Resources	Tammy Conforti, P.E.; Rene Vermeeren, P.E.
Lynn Merrill & Associates LLC	Lynn Merrill
California Geological Survey	Jeremy Lancaster, C.E.G Bill Short, C.E.G Thomas Spittler, C.E.G
California State University	Susan Lien Longville; Susan Carpenter; Dr. Kent Schofield; Suzie Earp; Gigi Hanna; Lisa Pierce (**Water Resources Institute, San Bernardino**); Boykin Witherspoon (**Center for Geographic Information Science Research, Cal Poly Pomona**)
University of California	Dr. Cameron Barrows (**UCR Extension**); Dr. Bowman Cutter; Dr. Thomas Scott (**UC-Riverside**)
Bingham McCutchun LLP	Marc R. Bruner

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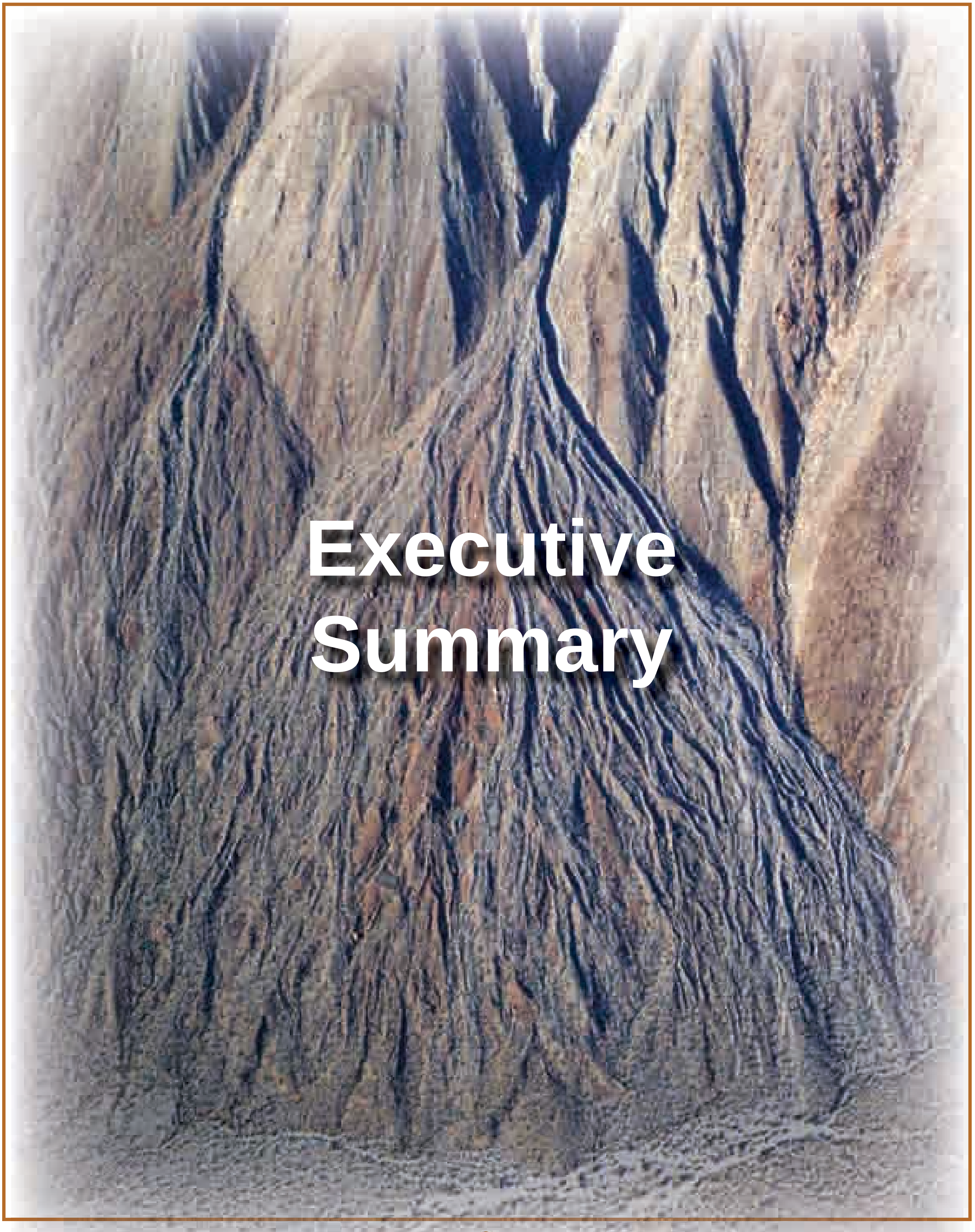
Executive Summary



In December of 2002, the California Floodplain Management Task Force Report recommended that "The State should convene a task force specifically for alluvial fans, with stakeholder participation, to review the state of knowledge regarding alluvial fan floodplains, determine future research needs, and, if appropriate, develop recommendations relating to alluvial fan floodplain management, with an emphasis on alluvial fan floodplains that are being considered for development."

In September of 2004, Governor Arnold Schwarzenegger signed Assembly Bill 2141 (see Appendix A), which recommended the creation of the Alluvial Fan Task Force (Task Force). The Director of the Department of Water Resources (DWR) convened the Task Force in December of 2007 after funding to support Task Force activities was secured from a Pre-Disaster Mitigation Planning Grant from the Federal Emergency Management Agency (FEMA) and a state match was authorized by Assembly Bill 466 (see Appendix A). Funding supported the tasks charged to the Task Force including:

1. Review the state of knowledge regarding alluvial fan floodplains;
2. Determine future research needs;
3. Develop a voluntary locally-adopted model ordinance for communities subject to alluvial fan flooding that supports land use decisions on alluvial fans;
4. Develop local planning tools to assist local communities evaluate development on alluvial fans; and
5. Prepare recommendations relating to alluvial fan floodplain management.

Appointments to the Task Force by DWR Director Lester Snow represented a broad range of interests. Members included elected officials, represented by five Supervisors from Kern, Los Angeles, Riverside, San Diego and San Bernardino County where future alluvial fan development is projected. Appointments also included representatives of the development and environmental community, local floodplain managers and associated state and federal agencies, including the Federal Emergency Management Agency (FEMA), plus at-large members representing other issues related to future development on alluvial fans. The entire process was coordinated by the Water Resources Institute at California State University San Bernardino. The organization, purpose and management of the Task Force are described in the Task Force Charter in Appendix B.

The members of the Task Force were assisted by a management team comprised of state and federal agencies, technical consultants from the private sector, and academic experts from California State University and the University of California. Task Force consultants and outside experts presented members with a thorough review of the state of knowledge related to development on alluvial fans in Southern California, focused largely on lessons learned, and then attention turned to examining the flood risks and the beneficial values on alluvial fan floodplains.

The Task Force recognized the complexity of issues concerning alluvial fan floodplain management and future land use decisions on alluvial fans. The members were assisted by a management team comprised of state and federal agencies, technical consultants from the private sector, and academic experts from California State University and the University of California. Task Force consultants provided members with a thorough review of the state of knowledge related to development on alluvial fans in Southern California, focusing on the history of flooding on alluvial fans and lessons learned including the costs of development on alluvial fans and long-term impacts to local governments. Then attention turned to examining the flood risks and the beneficial values on alluvial fan floodplains that included geomorphology, hydrology and hydraulic characteristics, the ecology of the alluvial fan environment, beneficial values of alluvial fans and watershed management.

The study area of the Task Force included the 10 Southern California counties of Los Angeles, Kern, San Bernardino, Riverside, Orange, San Diego, Imperial, Ventura, Santa Barbara and San Luis Obispo as defined in Assembly Bill 2141. During the last period of explosive growth and development from 2000-2006, five counties in the study area approved more than one half million new residential construction starts in areas where alluvial fans are a predominant landform.[1] An advisory map prepared for the Task Force revealed approximately 40 percent of the study area may potentially contain areas where alluvial fans are present, as illustrated in Figure 1. [2]

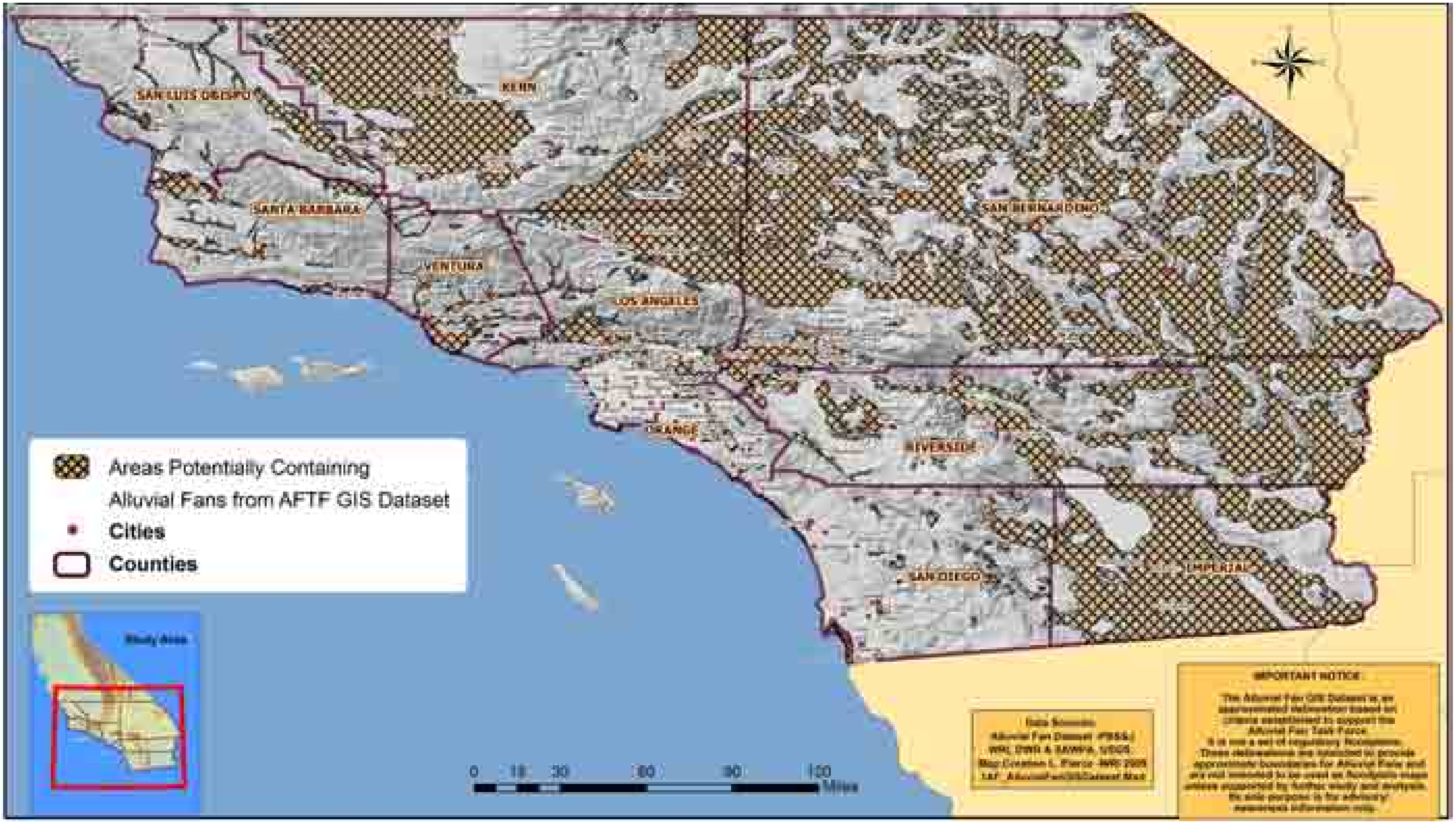


Figure 1: Areas Potentially Containing Alluvial Fans. *For advisory/awareness information only.* Source: Alluvial Fan Task Force

Development on alluvial fans has increased dramatically over the years because alluvial fans are generally regarded as attractive home sites, given their gentle slopes and panoramic views. Development on alluvial fans in the future will be an important consideration for Southern California communities that must ease their dependency on imported water supplies for additional growth. That is because alluvial fan sediments are typically good aquifers. Intensive development on alluvial fan sediments in the past within the Southern California region has resulted in significant losses of historical groundwater recharge.

The Task Force developed a suite of local planning tools for pre-project screening that are designed to assist local communities that need to plan for and evaluate future development proposals on alluvial fans. Flood management tools were also developed by the Task Force consistent with FEMA guidelines to analyze alluvial fan flood hazards and to formulate flood hazard protection. Together, these tools suggest how to incorporate multiple project objectives into future development on alluvial fans to ensure public health and safety, reduce the losses and damages caused by the natural hazards that may be present on alluvial fans, and conserve the beneficial values provided by alluvial fans. The local planning tools for pre-project screening and flood management tools are described in a separate guidance report entitled **"The Integrated Approach for Sustainable Development on Alluvial Fans"** (or *Integrated Approach*). An introduction to the *Integrated Approach* is provided in Appendix C.

The Task Force was also charged with developing a Model Ordinance pursuant to Assembly Bill 2141 that cities and counties with alluvial fans located within their jurisdictions may voluntarily adopt or modify as needed to meet local needs. The "Model Ordinance Governing Planning and Development on Alluvial Fans" is also included in the *Integrated Approach* and the full text is provided in Appendix D.

The *Integrated Approach* and Model Ordinance recognize the land use authority of local government by providing a non-prescriptive suite of methods that local communities can use at their own discretion to assist in the decision making process for future development proposals on alluvial fan areas. Furthermore, the tools are consistent with the goals and objectives of DWR's multi-faceted FloodSAFE program, a collaborative statewide effort designed to accomplish five broad goals:

1. Reduce the Chance of Flooding
2. Reduce the Consequences of Flooding
3. Sustain Economic Growth
4. Protect and Enhance Ecosystems
5. Promote Sustainability

Throughout the Task Force process, members collaborated to identify general findings that local governments should consider when planning for or considering future development on alluvial fans. These findings are discussed in greater detail in Chapter 2. Based on these findings, four categories of recommendations and 14 specific future actions emerged that the State and other public agencies should consider that are presented in this report. Chapter 3 discusses these recommendations in greater detail.

The premise for these recommendations is that an integrated approach that deals with the complex nature of alluvial fans is needed to support sustainable integrated regional resource, land use and floodplain management planning of alluvial fans. Future success is dependent upon the availability of improved data, tools and methods that encourage being smart up front, looking at the integrated nature of hazards and resources and not just the pieces, assessing risks and avoiding them as much as possible, putting sustainable financing and insurance programs in place to deal with long-term costs, and developing of integrated approaches that provide multiple benefits regionally.

Recommendations to Advance the Understanding of Alluvial Fan Flooding and Flood Hazards

Recommendation 1 - Floodplain Mapping: The DWR and local agencies should work with FEMA to continue updating existing Flood Insurance Studies (FIS) and companion flood insurance rate maps and launch new FIS in high risk alluvial fan areas where local governments expect future development.

Recommendation 2 - Better Characterization of Alluvial Fan Floodplains: The California Geological Survey (CGS) should work with the United States Geological Survey (USGS) and local agencies to continue development of Quaternary geologic maps in alluvial fan areas projected for future development in order to provide a better understanding of potential hazards.

Recommendation 3 - Improved Flood Hazard Protection Standards: Local flood management agencies should consider higher levels of flood management protection above the 100-year FEMA regulatory standard in planning for development in alluvial fan areas.

Recommendation 4 - Documentation of Historical Floods: Local flood management agencies should continue compiling information of past and current alluvial fan flooding events, building upon the historic flood research that was assembled by the Task Force.

Recommendation 5 –Gauged Stream and Precipitation Data: DWR in cooperation with the National Oceanic and Atmospheric Administration (NOAA), USGS, and local agencies should sponsor projects to address the lack of gauged stream and precipitation data to better quantify historical and future flood events on alluvial fan areas.

Recommendation 6 – Assessment of Existing Debris Basins: The State and local agencies should conduct an assessments of the adequacy of strategically located debris basins under a range of scenarios in urbanized areas in light of increased fire and post-fire debris-flow events.

Recommendations for Integration of Information on alluvial Fan Hazards, Beneficial Values and Long-Term Costs for Local Land Use Decisions

Recommendation 7 - Multiple-Objective-Management Strategies: DWR should promote multiple-objective alluvial fan water resource management measures as part of the broader Integrated Regional Water Management (IRWM) planning process as described in the economic tools in the *Integrated Approach* document. Local agencies should develop multiple-objective alluvial fan management strategies into their IRWM plans.

Recommendation 8 - Decision Support for Communities: The Task Force developed a web-based portal that allows interested parties using the Integrated Approach to access the pre-project screening and flood management tools and data for hazard and resource evaluation for special alluvial fan area being planned or proposed for development. The State should work with local agencies and universities to identify a process to maintain and further develop the database of the web-based portal.

Recommendations for Enhanced Support of Local Land Use Decisions

Recommendation 9 - Outreach for Integrated Approach: Local agencies and private developers should utilize the Integrated Approach tools to plan and evaluate future land use plans in alluvial fan areas. The State and local agencies and universities should support training for the public and private sector on the use of the Integrated Approach.

Recommendation 10 – Encourage Model Ordinance: The draft model ordinance is designed to ensure that land use decisions achieve three critically important objectives: (1) to minimize flooding and other hazards that are posed by locating development on alluvial fans; (2) to minimize the costs and damages that may result from these hazards; and (3) to preserve and maximize the flood protection, environmental and other beneficial values that alluvial fans provide. Local agencies are encouraged to adopt the draft model ordinance for future land use decisions on alluvial fan areas.

Recommendations for Technical Assistance and Funding

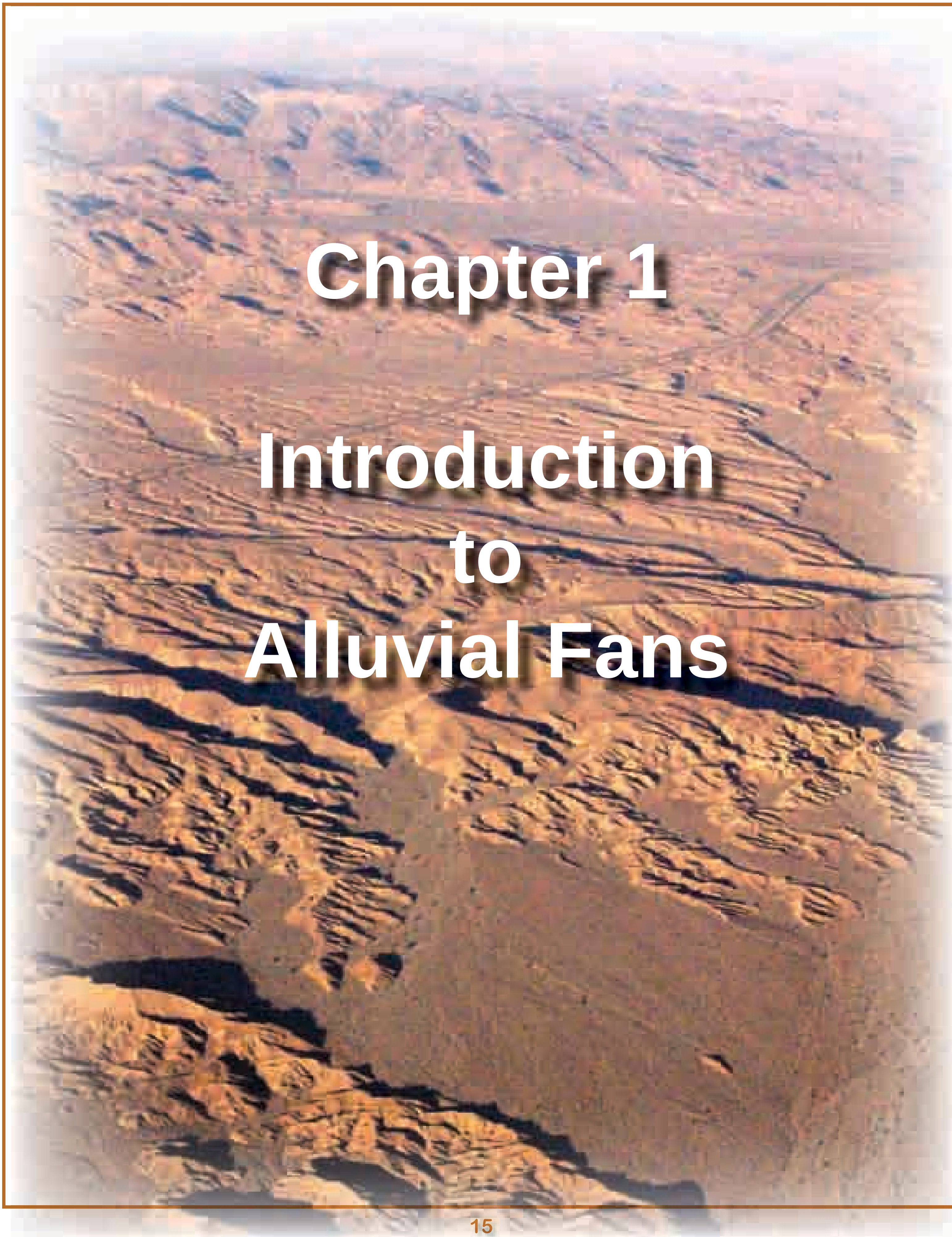
Recommendation 11 - Floodplain Delineation: DWR should continue to support the Alluvial Fan Floodplain Evaluation and Delineation (AFFED) program beyond 2012, until alluvial fans floodplains projected for development in the next decade have been completed. DWR should provide the alluvial fan maps and other hazard information for use by local governments and the public.

Recommendation 12 - Addressing Long-term Costs of Development: The State and local agencies should support implementation of economic strategies recommended in the IA that provide a sustained funding for future maintenance of flood management infrastructure.

Recommendation 13 - Structural Improvements for Existing Alluvial Fan Flood Management Infrastructure: The State should assist in finding a funding mechanism involving local cost sharing to investigate the needs for improvements to existing flood management infrastructures.

Recommendation 14 - Standards for Community Rating System Points: Standards for Community Rating System Points: The State and FEMA should inform local officials and the public about the benefits of the NFIP Community Rating System (CRS) insurance–rate adjusting program.

The Task Force worked with and considered diverse and conflicting interests and developed many consensus recommendations. This report attempts to summarize the findings and form recommendations on issues identified as important to Task Force members. None of the Task Force recommendations in the report preclude Task Force organizations or their members from raising issues that differ from items in the report.



Chapter 1

Introduction to Alluvial Fans

Chapter I

Introduction to Alluvial Fans

Description of Alluvial Fans

Alluvial fans are gently sloping fan-shaped landforms that are created over long periods of time by the natural deposition of eroded sediment from an upland source. They are generally exposed to long periods of dry weather interspersed with periods of heavy rain when alluvial fans permit the overland flow of vast quantities of flood water and sediment to the valley floor. Alluvial fans are a common landform (as shown in Figure 2) seen at the base of semi-arid mountain ranges throughout Southern California. The Task Force found that flooding is a normal process occurring on alluvial fans that sustains the beneficial values of floodplains. Understanding the natural processes of alluvial fans is an essential component of planning for future development that may occur.

Figure 2: Alluvial fan in East Deception Canyon, Riverside County, CA (Source: Jeremy Lancaster, California Geological Survey)

When alluvial fan flooding occurs, it is flashy and unpredictable. This type of flooding does not necessarily occur as the result of large amounts of rain. Often, it is triggered by intense rainfall over short periods of time. The natural flooding process that drives alluvial fan sedimentation tends to produce thick deposits of sand and gravel, particularly near the apex of the fan, with relatively minor proportions of fine-grained particles. Fine-grained sediment associated with flood flows may be transported to the valley floor.

Alluvial fan flooding differs from riverine flooding because flood flows in alluvial fan systems are often highly variable in magnitude. Compared to riverine flooding, there is considerably greater uncertainty in predicting the flow path of alluvial fan flooding with highly erosive soils mixed with water, rocks, boulders, trees and structural debris. Flood hazards on alluvial fans cannot be managed by riverine flood standards because the characteristics of alluvial fan flooding differ from the traditional riverine flooding paradigm. Also, riverine floodplains are quantified in linear miles, while alluvial fan floodplains are quantified in square miles. It is imperative for floodplain management to incorporate consideration of the existence of alluvial fans and to adequately evaluate the potential behavior of such fans with regard to developing the flood protection measures required for protection of life and property. The Task Force found that there is a greater uncertainty in predicting the flow path of alluvial fan flooding.

Some alluvial fans contain areas with flow path uncertainty in the location of active flood and debris flow inundation. Development in these locations generally requires structural flood management measures to provide adequate hazard projection. Others are no longer geologically active, meaning there is reduced risk of alluvial fan flooding that carries fine-grained sediment with flood flows to the valley floor. At the same time, alluvial fans that are being considered for future development may also be at risk from other hazards that are common to alluvial fans, including the risk for wildfires, post-fire debris flows or earthquakes.

The Task Force found that alluvial fan sediments are typically good aquifers. Many of the watersheds in Southern California have historically benefitted from the recharge capacity of alluvial fans. Research has shown that development on alluvial sediments in the Chino Basin reduced historical rainwater recharge capability an average of 14,000 acre-feet per year.[3] Estimates for the entire upper Santa Ana watershed are 30,000 acre-feet per year.[4]

The preservation of hydrological processes of alluvial fans is an important consideration for Southern California communities to ease dependency on imported water supplies. Enhancing the capacity of local supplies and placing a greater dependence on conservation and recycling is inextricably linked to land use decisions made by local governments. Alluvial fans also retain natural drainage patterns that enhance the hydraulic connectivity within watersheds runoff. This makes local decisions about whether to develop an alluvial fan a matter of weighing the benefits of increased housing and associated retail growth against the potential loss of groundwater recharge and other beneficial resources that may be diminished or lost entirely.

Conserving sediment transport is also important because a variety of habitat that protects endangered and threatened species is dependent upon the native flow of sediment in the alluvial environment. Sediment transport also sustains mineral extraction in the Southern California region, providing nearby sources for aggregate.

The Task Force found that although alluvial fans have common qualities, each alluvial fan is unique. Ecological settings vary significantly in Southern California's watersheds. Depending on the location, alluvial fans provide specific values, services and quality of life. For example, alluvial fans near urban areas serve as natural buffers between fire-prone mountain ranges and development in the valley.

Alluvial fans are characterized as areas of rapid geologic change. They can go through long periods of relative quiet, and then change dramatically from strong ground shaking and surface fault rupture by earthquakes on nearby faults. Those areas with relatively young sediment deposits are the most susceptible to seismically induced settlement during earthquakes. An accumulation of fine-grained sediment may pose hazards to building foundations. Hazardous materials such as radon and asbestos, and other potential hazards identified by local agencies, may also be relevant to consider when evaluating alluvial fans for development potential.

Property losses due to wildfires are an unfortunate consequence of residential development on alluvial fans. The topography of alluvial fans increases the intensity at which wildland fuels will burn. More active winds at night tend to increase the spread of fire from the highest point on the alluvial fan downward to areas where developments are located.

Geologic hazards on alluvial fans can change abruptly after a fire or storm. Fires greatly increase both the probability of debris flow occurrences and the volume of material that is transported from mountain canyons to alluvial fan surfaces. A wildfire causes dramatic changes to soils, vegetation, and surface litter—ranging from singeing to complete destruction. The heat and intensity of a wildfire can cause the creation of a hydrophobic (water repellant) layer beneath the ash and surficial soils, leaving scorched earth with a very limited capacity to absorb even the smallest amount of rain.

The public has learned how dangerous high-velocity mixtures of boulders, vegetation, sediment and water can be, particularly following wildfires. There is indication that wildfires may actually attract heavy rains. Research by the United States Geologic Survey (USGS) found that burned watersheds attract a higher percentage of thunderstorms than non-burned ones and that small amounts of rain—events that meet the two-to-five-year-flood recurrence interval threshold—can trigger major flooding and debris flows.

History shows that communities that fail to recognize and adequately plan for these hazards can suffer horrendous losses in life and property, as well as response and post-disaster clean-up costs that decimate federal, state and local fire protection budgets. The State's direct post-disaster recovery costs from flooding and wildfire in California have reached almost $7 billion dollars since 1950 which reflects only a portion of total disaster costs.[5] Disasters and corresponding losses are growing rapidly as the number of people and structures are increasing in Southern California. Large populations in the region are at medium-to-high risk of wildland fires and flooding.[6]

At the same time, climate change is projected to increase the severity of storms, extreme heat and prolonged drought, wildland fires, flooding, mudslides and landslides[7] in areas of Southern California where alluvial fans are present. Adapting to climate change, as projected by the California Natural Resources Agency, will require a heightened awareness among community leaders that extreme events in California will increase— especially wildfires and flooding.[8] The California Emergency Management Agency (CalEMA) projects that in addition to wildfires and flooding, climate change will increase the severity of storms, extreme heat and prolonged drought, mudslides and landslides[9] in areas of Southern California where alluvial fans are present.

While alluvial fans are a less stable environment for urban development than other landforms because alluvial layers consist of layer of coarse material that cover finer sediments can shift unexpectedly, most portions of alluvial fan floodplains can be considered for development given the appropriate flood protection measures. Local governments and flood management agencies will be financially responsible for the ongoing flood management and local government services.

State of Knowledge of Alluvial Fans

To prepare the Task Force for its work, a variety of experts provided a review of the state of knowledge related to alluvial fans, particularly the lessons learned from decades of development in Southern California. Geologists and engineers examined the physical characteristics (i.e., geomorphology, hydrology, hydraulics) of alluvial fans; the nature of alluvial fan flooding, which is distinct from other flood hazards; the hazards related to debris flows, the post-fire flooding regime, and the myriad challenges faced when managing alluvial fan flood risks.

Conservation biologists provided insight on conserving the ecology and beneficial values of alluvial fans. Undeveloped alluvial fans serve important hydrologic, environmental and open space functions by permitting the overland flow of large amounts of flood water and sediment. Future development on an alluvial fan could increase downstream flood hazards and compromise beneficial resource values including water supply, biodiversity, recreation value and amenity value.

Economists and public works experts examined the local costs associated with development on alluvial fans. Many of the new flood management facilities necessary for alluvial fan development were constructed by property developers. The future costs of these alluvial fan developments were largely unknown at the time. Today, local agencies recognize that the true costs of developing on alluvial fans can impact budgets for years to come including:

- Operating, maintaining and improving flood management facilities in perpetuity with revenues provided by property tax assessments of local flood control agencies;
- Emergency response, particularly to structures at risk from wildfires and post-fire debris flows borne by the entire community, not just those that reside on alluvial fans;
- Public services necessary to restore a development in the event that a natural disaster occurs which may not be reimbursable from disaster funds; and
- Loss of natural resources if development on alluvial fans results in significant modifications to groundwater recharge, critical habitat or open space that is highly valued by residents.

Historians for the Task Force examined the impacts of development on alluvial fans in the study area, looking at more than a half century of flooding events associated with periodic flooding on alluvial fans and downstream alluvial floodplains. Historical records throughout the study area found that the region has a history of periodic flooding on alluvial fans and downstream alluvial floodplains. Historical records indicated that serious flooding was sometimes the result of small isolated rain events, rather than major regional storms. Research also found that high-velocity, debris-laden flows on alluvial fans have often been triggered by storms following wildfires on alluvial fans resulting in damage to the structures located on alluvial fans and downstream flooding as illustrated in Figures 3 and 4.

Fortunately, lessons have been learned from alluvial fan development in Southern California. In the City of La Canada[10], located in Los Angeles County, population increased from 150 in 1908 to several thousand in the early 1930s. When wildfires burned hills above La Canada in November of 1933, 40 lives were lost to debris flooding and approximately $5 million in damage sustained.[11]The discovery that existing sand and gravel pits in the area prevented damage downstream led to the concept of debris basins, now widely used throughout the Southern California study area.[12] Between 1935 and 1968, 106 debris basins were constructed to prevent downstream flood damage.[13] While the floods of 1969 did result in over $30 million in damage and the loss of 73 lives, the County estimated that the investment in debris basins and other infrastructure prevented over $100 billion in damage.[14] Heavy rainfall also occurred in 1972-73, 1977-78, 1979-80, 1982-83, 1992-93, 1995-96 and 1997-98.[15] Once again, the county estimated the debris control facilities prevented billions of dollars in damages. While these debris basins are effective at retaining debris and reducing downstream hazards, they are costly to maintain. They must be cleaned when sediment accumulates and capacity is reduced. Between 1921 and 2007, Los Angeles County reports that 12.5 million cubic yards of sediment was removed from debris basins at an annual cost of $1.5 million.[16] Approximately 84.3 million cubic yards of debris was removed from dams between 1920 and 2007 – enough to cover 82 square miles with one foot of sediment. Sediment removal from dams in Los Angeles County averages 1 million cubic yards annually.[17]

Figure 3: Wildfire consumes the hillsides near homes in San Bernardino Co. Source: Tom O'Keefe, CALFIRE

Figure 4: A house in San Bernardino County is inundated by a debris flow following a heavy rain event on Christmas Day after the 2003 wildfires. Source: Dr. Norman Meek, California State University, San Bernardino

Los Angeles County officials say it will cost up to $30 million to clean out debris basins that helped protect foothill neighborhoods from mudslides during the most recent 2010 winter storms.[18] Storms filled many basins in areas of the San Gabriel Mountains north of Los Angeles that burned in last year's massive Station wildfire. County Supervisor Michael Antonovich estimated one million cubic yards of additional mud, boulders and timber needs to be removed from the basins before more rain comes.[19] The Board of Supervisors voted to waive fees and tonnage limits at local landfills after the storm to accommodate the need.[20] One debris basin overflowed, causing mud damage to 43 homes in the foothill town of La Canada Flintridge.[21]

Single-purpose flood management infrastructure was the predominant approach for hazard protection to accommodate alluvial fan development in the past. The preferred approach today is to consider whether flood management can be integrated with objectives that may conserve beneficial values provided by alluvial fans. Increasingly, alluvial fan floodplains are seen as local resources that can provide opportunities for development and groundwater recharge, critical habitat, open space, and, recreation that can be integrated with flood management.

There has been innovation, engineering and thought in recent years resulting in alluvial fan development that addresses multiple objectives. One example is the San Sevaine wash, which drains approximately five square miles of the San Gabriel Mountains. Flood hazards, including intermittent debris flows, are intensified when the watershed is totally or partially burned. Alluvial fans at the base of the San Bernardino Mountains provide groundwater recharge areas in the upper Santa Ana River watershed.

To accommodate development in the vicinity of San Sevaine, a preserved active wash was retained as illustrated in Figure 5. The wash is approximately 8,000 feet long and 1500 feet wide, using levees armored with rock facing, ranging from 10 feet to 15 feet in height. The wash isolates the active fan areas downstream of the apex of the fan, eliminating the need for a debris basin at the mouth of the canyon and a concrete channel to convey the outflow. New development has been clustered on both sides of the wash.

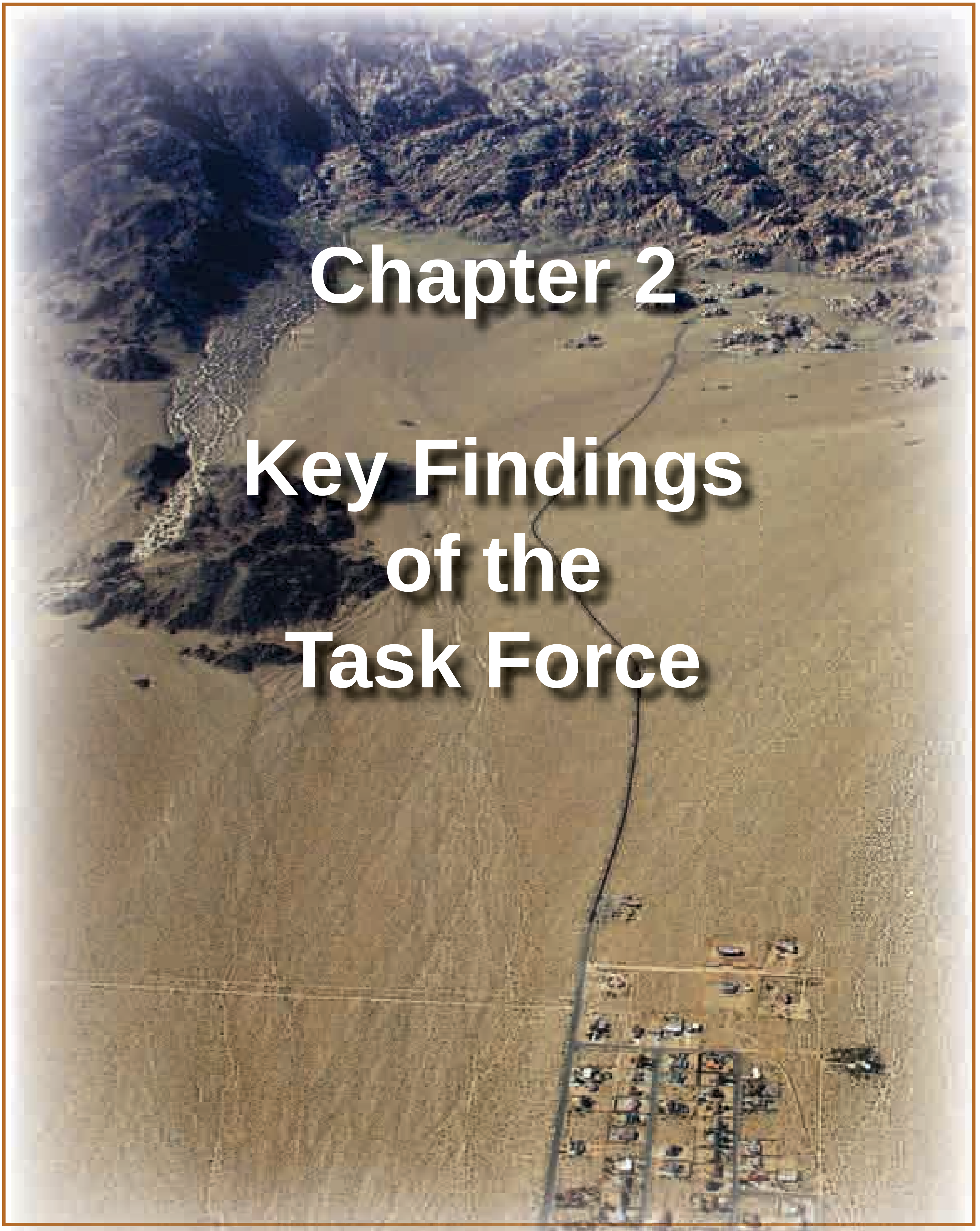
This project provides multiple benefits. The ongoing costs for maintenance of debris basins and concrete channels were eliminated in the area of the preserved active wash. Historic groundwater recharge and a significant portion of the riparian habitat were preserved. An additional aesthetic benefit to the community is that development adjacent to open space is preferred by the homeowners. And, by avoiding development in the area of greatest risk, public health and safety was ensured and future losses from natural hazards were reduced.

Figure 5: Preserved active San Sevaine wash, Rancho Cucamonga, CA. Source: ESRI ArcGIS Explorer image

Multiple agencies in many regions of Southern California would benefit by considering multiple objective strategies related to future development on alluvial fans. It takes significant time for local agencies within a region to plan joint projects. By incorporating joint projects in Integrated Regional Water Management (IRWM) plans, there is an opportunity to compete for cost-sharing measures made possible by previous voter-approved bonds. Defining multiple objectives in alluvial fan areas that are larger than the footprint of a proposed development can improve outcomes because more opportunities are present at this scale.

Chapter 2

Key Findings of the Task Force



Chapter II

Key Findings of the Task Force

Development on alluvial fans located at the urban interface in Southern California is likely to continue, meaning significantly more people will be living in these areas in the future. Geologic data shows that a significant portion of the remaining developable land in Southern California is situated on alluvial fans. Living and developing on alluvial fans means paying close attention to all the various risks that may be present in order (1) to minimize flooding and other hazards that are posed by locating development on alluvial fans; (2) to minimize the costs and damages that may result from these hazards; and (3) to preserve and maximize the flood protection, environmental and other beneficial values that alluvial fans provide.

The wisdom of sustainable development—that which meets today's needs without prejudicing the ability of future generations to meet their own needs—should not be ignored. Task Force members universally agreed that flood management demands already exceed available resources. To quantify the extent of the problem, the Task Force commissioned an economic analysis of two randomly selected counties in its Southern California study area. Self-reported deferred maintenance estimates in these areas ranged from $50 million to $2 billion.[22] The analysis found that the majority of revenue for operation and maintenance of flood management infrastructure is provided by flood control property tax assessments. After adjusting for inflation, the assessments in these two counties resulted in only moderate increases in property tax revenues from 1993 to 2006, during a time of unprecedented growth.[23] Deep losses in real estate values in both counties since 2007 are expected to reduce future property tax assessments for some time, further constraining the ability of local and regional governments to meet their flood management needs.

The efforts of the Task Force, therefore, were intended to find a way to address these needs in a way that met the needs of a wide variety of stakeholders. One of the greatest benefits of the Task Force was the forum it provided for a broad range of interests to reflect on lessons learned from past development on alluvial fans in Southern California. The findings of the Task Force were based on a comprehensive review of the state of knowledge of the alluvial fan floodplains, lesson learned from development on alluvial fan areas, and the assessment of the multiple hazards and beneficial values that exist on alluvial fans.

Experience has demonstrated that the Southern California region needs to undertake alluvial fan land use in an integrated context. Although the Alluvial Fan Task Force effort grew out of concern for effective alluvial fan floodplain management, the tools, techniques and considerations that evolved in *the Integrated Approach* can and should be applied in the broader arena of land use in coordination with floodplain management and integrated regional water management planning.

The findings of the Task Force fall into four major categories:

1. Insufficient Understanding of Alluvial Fan Flooding and Flood Hazards
2. Lack of Integration of Information on Alluvial Fan Hazards, Beneficial Values, and Long-term Costs for Local Land Use Decisions
3. Enhanced Support for Local Land Use Decisions
4. Insufficient Technical Assistance and Funding

Insufficient Understanding of Alluvial Fan Flooding and Flood Hazards

One of the most significant challenges related to future development on alluvial fans is an insufficient understanding about alluvial fan flooding and other flood hazards potentially present, not by local flood management agencies, but by local governments that plan for and evaluate future development on alluvial fans. Many alluvial fan floodplains have already been developed in Southern California and more alluvial fans are projected for future development. The Task Force found that the identification and mapping of alluvial fan flood hazards is not keeping up with the demand for that information. FEMA maps are not available for all alluvial fans in Southern California projected for development because Flood Insurance Studies (FIS) have not been completed. As a result, there is low density rural development where flood hazards may be present with no community participation in the National Flood Insurance Program (NFIP). For land use planning purposes, the Task Found there is an information gap that may continue for some time from the lack of available information.

As a result, technical consultants to the Task Force from the California Geological Survey (CGS) are compiling a GIS data set of regional-scale advisory maps for some of the areas that are most likely to be developed in the 10-county Southern California Study Area where no FEMA maps are available. They are scheduled to be published by the California Department of Water Resources (DWR) and the California Geological Survey (CGS) as part of the Task Force work product in 2010. The advisory maps identify areas generally underlain by Quaternary age (about two and one-half million years ago) sediments. Quaternary geologic maps (also termed surficial geologic maps) provide an important data source for understanding the composition of alluvial fans because these landforms are created by the deposition of alluvium transported to the fan surface by repeated flooding. It is important to note that Quaternary maps used to provide a preliminary identification of whether a site is located on an alluvial fans does not replace FEMA guidelines for determining if a site is located on an alluvial fan for federal flood hazard identification purposes. FEMA recommends that project teams use this identification only for planning purposes in undeveloped alluvial fan areas where no Flood Insurance Rate Maps (FIRMs) exist.

The 100-year flood is the standard used by the National Flood Insurance Program (NFIP) to determine the need for mandatory flood insurance on alluvial fans. Historic flood discharge data records are incomplete, too short, or non-existent. Therefore, flood frequency probabilities computed from this data may not be representative of future extremes. Long-term sediment and debris yields or single event debris flow volumes are difficult to model without the benefit of verification with hydrograph data and debris basin cleanout records. These uncertainties, coupled with increases in runoff as areas in the watersheds are built-out, make quantitative evaluation of flood magnitudes difficult and could result in a false sense of understanding of this complex issue. For example, with development and watershed modifications, a flood that was equal to the 100-year event on existing flood maps may now occur more frequently due to these alterations. The problems associated with assigning magnitude and frequency values to alluvial fan floods is even greater than riverine flooding because of the random nature of these events. Historians for the Task Force examined flood accounts and historical records at flood control agencies throughout the Southern California region. Some counties have invested significant resources documenting flooding but others have lacked the resources for historic document management resulting in poor, almost non-existent records. The historians for the Task Force pointed out that because alluvial fans go through long periods of relative quiet between flood events, it is essential that all past flood records are available to floodplain managers when conditions dramatically change.

Since 1950, counties in the Task Force study area where alluvial fans are present have been declared flood disaster areas at least three times.[24] By 2006, more than 55% of the State's total population was clustered in just eight counties.[25] Five those counties (Riverside, Los Angeles, San Diego, San Bernardino and Orange) are located in the Southern California Study Area where more than one half million new residential construction starts were recorded from 2000-2006.[26]

The Task Force also found that communities which chose to adopt floodplain management practices that exceed minimum National Flood Insurance Program (NFIP) standards may be eligible for benefits under the Community Rating System established by FEMA. Flood insurance premiums for residents of communities participating in the Community Rating System are lowered to reflect the reduced flood risk that is a result of community activities that meet three goals: (1) reduce flood damage to insurable property; (2) strengthen and support the insurance aspects of the NFIP; and (3) encourage a comprehensive approach to floodplain management. Policyholders in Community Rating System communities receive premium discounts ranging from 5 percent to 45 percent. Some of the tools developed by the Task Force help communities determine whether going beyond the minimum standards is locally cost-effective. About 14% of the California communities in the National Flood Insurance Program are in the CRS. They have 55% of the State's flood insurance policies. The program saves California residents over $11 million each year.[27] One of DWR's goals is to increase California's participation in the CRS to about 20 percent.

Lack of Integration of Information on Hazards, Beneficial Values, and Long-Term Costs for Local Land Use Decisions

The Task Force found that future land use planning and land use decisions would benefit from integrating the consideration of flood hazards in conjunction with other hazards, beneficial resources potentially impacted, and a better understanding of the long-term costs, both monetary and environmental.

In addition to the risk of alluvial fan flooding, the Task Force found that other hazards should be evaluated at alluvial fan sites. These include surface fault rupture, seismic shaking, landsliding, naturally-occurring hazardous minerals and hazardous materials, wildfires and other hazards such as post-fire debris flows. Preferably, these should be evaluated during the planning phase before specific projects are proposed.

Four types of resources on alluvial fans may be impacted by development on alluvial fans: water supply, biodiversity, recreation value and amenity value. Fortunately, the economic value of these resources can be measured when evaluating future development in alluvial fan locations. Procedures for estimating the economic values of resources by nonmarket valuation can be applied that identify the value of resources. Water supply as a valuable resource to conserve will play a significant role in evaluating development on alluvial fans.[18]

The Task Force found that integrating information about known hazards and beneficial values on alluvial fan sites along with projections of future costs and long-term costs may indicate to local governments that it would be preferable to avoid development in the most hazardous or ecologically valuable areas while accommodating it in the most suitable locations on the alluvial fan sites. This would also be consistent with California's FloodSAFE Vision for a sustainable integrated flood management and emergency response system throughout California that improves public safety, protects and enhances environmental and cultural resources, and supports economic growth by reducing the probability of destructive floods, promoting beneficial floodplain processes, and lowering the damages caused by flooding.

The Task Force found there may be opportunities on alluvial fans where multiple-objective-management strategies would be beneficial. These strategies can be incorporated as components of the broader Integrated Regional Water Management planning process. And, the periodic update of local General Plans is an ideal time for local governments to begin planning for alluvial fan areas that are being considered for future development and start dialogue with local flood management agencies.

Enhanced Support for Local Land Use Decisions

The Task Force found that planning commissioners and elected officials making land use decisions are often presented with technical information late in the development process and generally in a format that is too technical for those without scientific training to readily understand. Information needs to be provided in a format that allows public servants to visualize that hazards and resources present on alluvial fans may impact future development or compromise the sustainability of the community.

This finding led the Task Force to develop local planning tools that are published in a separate guidance document entitled "The Integrated Approach for Sustainable Development on Alluvial Fans" (*Integrated Approach*). It contains an integrated suite of pre-project screening tools that are unique to the alluvial fan environment. The tools provide a method for local governments to conveniently access public data about hazards and resources from a web-based portal. Software on the portal allows users to select an area and import this public data resulting in a "map" for decision makers to visualize the hazards and resources present early in the land use process.

As with any new technique, public outreach will be necessary to bring the *Integrated Approach* to the communities with undeveloped alluvial fans that anticipate future development. Training should be provided on a regional basis in workshops and other formats for planners in the public and private sector, developers, environmental groups and other agencies. The web-accessible portal that has been developed for the *Integrated Approach* (http://cgisr-aftf.win.csupomona.edu/Portal/ptk) that provides a mechanism for web users to import real-time data about hazards and resources from public sources and create a "map" that visualizes the distribution of hazards and resources on a particular alluvial fan site.

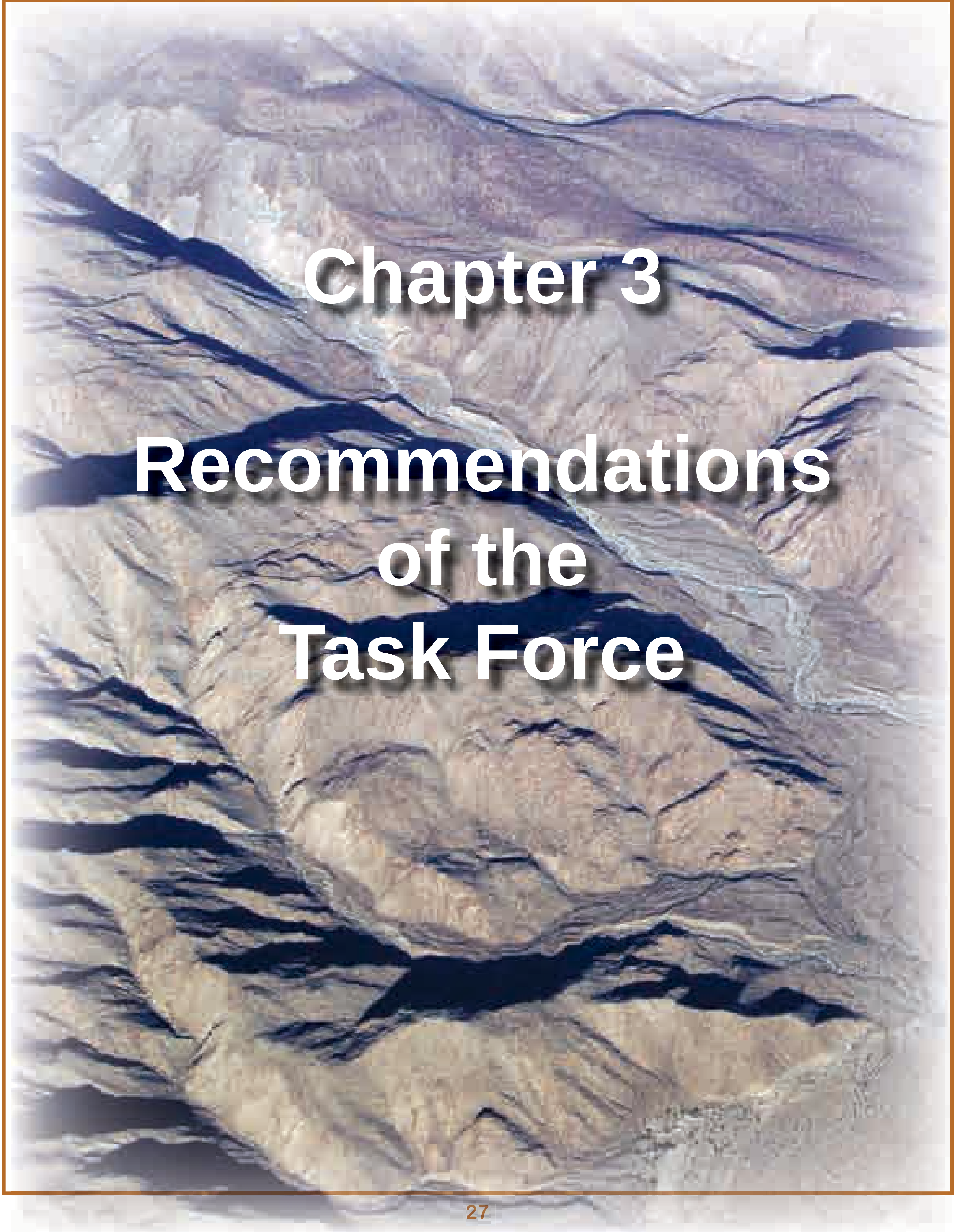
In examining the state of knowledge related to development on alluvial fans, the AFTF also found a lack of consistency within the Southern California region in practices utilized to address alluvial fan conditions. This was a concern that was consistently voiced by developers serving on the task force that were frequently unable to justify the efficacy of a method that was used elsewhere in another jurisdiction.

This led the Task Force to begin assembling a database about the land use practices used by various agencies. Practices are catalogued in an MS Access database by technical consultants that contains entries from local ordinances, local or multi-jurisdictional Hazard Mitigation Plans (HMPs), General Plans, Flood Mitigation Reports, Project Area Studies and other types of data from the 10-County Southern California study area (Imperial, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Luis Obispo, Santa Barbara and Ventura counties). Future funding for the portal will build upon the database to incorporate new knowledge as science, building techniques and sustainable practices evolve and carry it forward throughout the region in a systematic manner.

Insufficient Technical Assistance and Funding

DWR established a four-year Alluvial Fan Floodplain Evaluation and Delineation (AFFED) program in 2008 within the FloodSAFE program and authorized by Proposition 84. AFFED is aimed at improving the quality and accuracy of alluvial fan flood hazard data. It makes mapping available to local communities, providing local agencies the necessary tools to understand the characteristics and potential hazards of alluvial fan floodplains and to understand the trade-offs of new development compared to the loss of open space. The goal of AFFED is to map alluvial fan flood hazard areas within the study area of the ten Southern California counties over the four-year program. Unfortunately, AFFED funding will be exhausted in 2012 before many of the alluvial fan areas projected for future development can be addressed.

The Task Force also recognized that as a result of several State flood related laws that were enacted in 2008, local communities will be required to address additional flood hazard and land use data in future General Plan element updates. Information to comply with these new general plan requirements for alluvial fan areas may be difficult to obtain. Also, local governments are concerned on how these unfunded mandates will be accomplished. The General Plan Conservation Element must identify rivers, creeks, streams, flood corridors, riparian habitats, and land that may accommodate floodwater for purposes of groundwater recharge and stormwater management; the Land Use Element must annually identify and include areas subject to flooding in the General Plan; and the Safety Element must identify information about the flood hazards and flood risk.



Chapter 3

Recommendations of the Task Force

Recommendations of the Task Force

The Task Force developed specific recommendations to improve public health and safety, preserve the beneficial values of alluvial fans, and support economic growth by reducing the probability of destructive floods and damages from the natural hazards present. The recommendations were developed to address the key findings discussed in Chapter II. These recommendations are grouped into four categories as listed below:

1. Recommendations to Advance the Understanding of Alluvial Fan Flooding and Flood Hazards
2. Recommendations for Integration of Information on Alluvial Fan Fans Hazards, Beneficial Values, and Long-term Costs for Local Land Use Decisions
3. Recommendations for Enhanced Support for Local Land Use Decisions
4. Recommendations for Technical Assistance and Funding

Recommendations to Advance the Understanding of Alluvial Fan Flooding and Flood Hazards

1. Floodplain Mapping

Issue: *Local governments project that there could be significant development in Southern California in areas where alluvial fans may be present. The Task Force found that the identification and mapping of alluvial fan flood hazards is not keeping up with the demand for that information. FEMA maps are not available for all alluvial fans in Southern California projected for development because Flood Insurance Studies (FIS) have not been completed. For land use planning purposes, the Task Force found there is an information gap that may continue for some time from the lack of available information.*

Recommendation 1: DWR and local agencies should work with FEMA to expand the effort updating existing Flood Insurance Studies (FIS) and companion floodinsurance rate maps and launch new FIS in high risk alluvial fan areas where local governments expect future development.

2. Better Characterization of Alluvial Fan Floodplains

Issue: *Local governments are responsible for determining when land use zoning should be changed and approving new developments. For land use planning purposes, the Task Force found that there is a lack of informational during the time that discussions between local governments and developers first begin before Flood Insurance Studies are completed. Better characterization of alluvial fan floodplains is consistent with the pre-project screening approach in the Integrated Approach. FEMA acknowledges that the screening approach may be adopted by project teams for planning purposes in undeveloped alluvial fan areas where no Flood Insurance Rate Maps (FIRMs) exist before FEMA requirements dictate that hazard maps show, at a minimum, the 100-year flood hazard boundary on the FIRM.*

Recommendation 2: The California Geological Survey (CGS) should work with the United States Geological Survey (USGS) and local agencies to continue development of Quaternary geologic maps in alluvial fan areas projected for future development in order to provide a better understanding of potential hazards. The Task Force recommends an increase in state and federal funding for this critical activity.

3. Improved Flood Hazard Protection Standards

Issue: *The 100-year flood event and the 100-year flood hazard boundary depicted on FIRMs were never intended to imply that these are the only areas where flood hazard risks may be present. Unfortunately, it has become a common misconception and mapped flodplains are often misconstrued as definite boundaries. Coupled with increases in urban runoff on alluvial fans floodplains that are highly developed, a quantitative* *evaluation of flood frequency probabilities and magnitudes on FIRM maps is difficult . A flood equal to the 100-year event on an existing flood map may occur more frequently due to these alterations resulting in a false sense of security from the literal interpretation of the 100-year flood hazard boundary depicted on FIRMs. Many local flood management agencies recognize the risk at the 100-year flood threshold and plan appropriately to address those uncertainties.*

Recommendation 3: Local flood management agencies should consider higher levels of flood management protection above the 100-year FEMA regulatory standard in planning for development in alluvial fan areas.

4. Documentation of Historical Floods on Alluvial Fans

Issue: *Southern California covers a wide and diverse territory with each flooding event telling a unique story. No flood replicates any other flood, even when the events happen in the same geographic location. Some counties in Southern California have compiled their flood accounts and maintained historical records well. Other counties have lacked the resources for historic document management resulting in poor, almost non-existent records.*

Recommendation 4: Local flood management agencies should continue compiling information of past and current alluvial fan flooding events, and share new information on the Integrated Approach portal, building upon the historic flood research that was assembled by the Task Force.

5. Lack of Gauged Stream and Precipitation Data

Issue: *Historic discharge and precipitation data is scarce and may not be representative of future stream flow and precipitation extremes. Many historic stream gauging stations have been damaged, removed or destroyed in flood events and need to be reinstalled to better characterize the flood risk. These uncertainties, coupled with increases in runoff as areas in the watersheds that are built-out, make quantitative evaluation of flood magnitudes difficult and can result in a false sense of understanding of this complex issue.*

Recommendation 5: DWR in cooperation with the National Oceanic and Atmospheric Administration (NOAA), USGS, and local agencies should sponsor projects to address the lack of gauged stream and precipitation data to better quantify historical and future flood events on alluvial fan areas.

6. Assessment of Existing Debris Basins

Issue: *The increased severity, frequency and intensity of wildfires in Southern California increases flood risk on alluvial fans because many of the structures on alluvial fans are subject to fire risk and prone to post-fire debris flows. Many of the debris basins that were constructed some time ago did not anticipate the increased severity and intensity of wildfires or the additional developments that would follow. The California Emergency Management Agency also projects that climate change will further increase the severity of storms, wildland fires, flooding, mudslides and landslides in areas of Southern California where existing debris basins are located.*

Recommendation 6: The State and local agencies should conduct assessments of the adequacy of strategically located debris basins under a range of scenarios in urbanized areas in light of increased fire and post-fire debris flow events.

Reccomendations for Integration of Information on Alluvial Fan Hazards, Beneficial Values, and Long-Term Costs for Local Land Use Decisions

7. Multiple-Objective-Management Strategies

Issue: *Multiple agencies would benefit by considering reasonable and cost- effective strategies related to future development on alluvial fans that address multiple objectives. It takes time for local agencies to incorporate multi-objective projects into Integrated Regional Water Management (IRWM) Plans, such as accommodating new development with multiple-benefit measures that reduce future losses to human, built and natural resources, consistent with DWR's FloodSAFE vision. Defining multiple objectives in alluvial fan areas that are larger than the footprint of a proposed development can improve outcomes because more opportunities are present at this scale.*

Recommendation 7: DWR should promote multiple-objective alluvial fan management measures as part of the broader IRWM planning process as described in the economic tools within the *Integrated Approach* document. Local agencies should encourage development of multiple-objective alluvial fan management strategies in IRWM plans.

8. Decision Support for Communities

Issue: *Nationally, flood insurance claims in areas outside the mapped "100-year" floodplain account for 31 percent of the claims paid for flood damage.[28] The Task Force developed a suite of pre-project screening tools; flood management tools consistent with consistent with FEMA guidelines to analyze alluvial fan flood hazards and to formulate flood hazard protection; and a web-based portal that provides information and data to assist communities in planning for and evaluating land use in alluvial fan areas. Developers on the Task Force reported they encounter significant differences among local agency practices in Southern California. Measures for addressing hazards and resources on alluvial fans vary so widely among counties and cities that sharing practices for decision support may reduce jurisdictional barriers among local communities where alluvial fans are developed.*

Recommendation 8: The Task Force has developed a web-based portal that allows interested parties using the *Integrated Approach* to access the pre-project screening and flood management tools and data for hazard and resource evaluation for special alluvial fan area being planned or proposed for development. The State should work with local agencies and universities to identify a process to maintain and further develop the database of the web-based portal (http://cgisr-aftf.win.csupomona.edu/Portal/ptk).

Reccomendations for Enhanced Support for Local Land Use Decisions

9. Outreach for *Integrated Approach*

Issue: *Decision makers need information conveyed in a format that is easily understood and allows them to visualize complex layers of information about hazards and resources present to support land use decisions on alluvial fans. Rarely is this the case. Rather, information about hazards and resources is buried in environmental documents that are too technical to be of practical use. The pre-project screening tools and flood management tools in the Integrated Approach were developed to identify the general distribution of those hazards and resources on the alluvial fan site, providing an opportunity for decision makers and planners to consider the suitability of the proposed development and whether multiple objectives can be addressed in a locally cost-effective manner. Economic strategies included in the Integrated Approach address the long-term* *costs associated with development on alluvial fans. Methods are suggested to assemble the most hazardous or ecologically valuable portions of alluvial fans while accommodating new development using transfers and purchases of property rights from willing sellers. There are also tools for designing developments on alluvial fans to accommodate post-disaster cleanup.*

Recommendation 9: Local agencies and private developers should utilize the *Integrated Approach* tools to plan and evaluate future land use plans in alluvial fan areas. The State and local agencies and universities should support training for the public and private sector on the use of the *Integrated Approach*.

10. Encourage Model Ordinance

Issue: *To implement the local planning tools described in the Integrated Approach, the Task Force developed a Model Ordinance (MO) that cities and counties with alluvial fans located within their jurisdictions may consider for local adoption. The MO sets forth procedures and substantive factors to be considered for local land use decisions involving alluvial fan areas, including both planning-level decisions associated with periodic General Plan updates and project-level decisions for individual development projects as they are proposed. The ultimate goal is for local communities to utilize the best available scientific information to ensure that planning and development on alluvial fans is smart, safe and sustainable. Local communities may, at their discretion, adopt the MO or revise it as appropriate to suit local needs and conditions. In all cases, local communities are encouraged to consider and utilize the local planning tools as early as possible in the land use planning process, with the aim of promoting decisions that take into account the unique hazards and benefits posed by the particular alluvial fan at issue. The draft MO provides a systematic process for local governments to consider in reviewing and evaluating development proposals on alluvial fan areas.*

Recommendation 10: The draft model ordinance is designed to ensure that land use decisions achieve three critically important objectives: (1) to minimize flooding and other hazards that are posed by locating development on alluvial fans; (2) to minimize the costs and damages that may result from these hazards; and (3) to preserve and maximize the flood protection, environmental and other beneficial values that alluvial fans provide. Local agencies are encouraged to adopt the draft model ordinance for future land use decisions on alluvial fan areas.

Reccomendations for Technical Assistance and Funding

11. Floodplain Delineation

Issue: *DWR established a four-year Alluvial Fan Floodplain Evaluation and Delineation (AFFED) program in 2008 within the FloodSAFE program through Proposition 84 funding. AFFED is aimed at improving the quality and accuracy of alluvial fan flood hazard data. It makes mapping available to local communities, providing local agencies the necessary tools to understand the characteristics and potential hazards of alluvial fan floodplains and to evaluate the benefits of new development compared to the loss of open space that provides natural flood protection. Unfortunately, AFFED funding will be exhausted in 2012 before many of the alluvial fan areas projected for future development can be addressed.*

Recommendation 11: DWR should continue to support the Alluvial Fan Floodplain Evaluation and Delineation (AFFED) program beyond 2012, until alluvial fans floodplains projected for development in the next decade have been completed. DWR should provide the alluvial fan maps and other hazard information for use by local governments and the public.

12. Addressing Long-Term Costs of Development

Issue: *The tendency to ignore the long term costs and impacts of development on alluvial fans is likely to continue unless measures are taken to sustain investments on a regular basis. The nature of infrastructure and floodway maintenance is better served by consistent sustained funding rather than episodic investments.*

Recommendation 12: The State and local agencies should support implementation of economic strategies recommended in the *Integrated Approach* that provide a sustained funding for future maintenance of flood management infrastructure.

13. Structural Improvements for Existing Alluvial Fan Flood Management Infrastructure

Issue: *Deferred maintenance and inventory of structural improvements needed on existing flood management infrastructure greatly exceeds the capacity of local agencies, putting significant numbers of people and structures at risk. Local agencies need to address these issues as soon as possible to reduce future losses to people and structures already located on developed alluvial fans. An economic analysis prepared for the Task Force compared property tax and other revenues over a 10-year period, after adjusting for inflation in two randomly selected counties in the Southern California Study Area. With currently declining values in real estate in both counties, estimated losses in revenue for local flood management are projected for as much as 40% in 2009, with future revenues expected to decline even further. At the present time, flood management demands are exceeding available resources in one county by an estimated $2 billion in deferred costs. Another county reported deferred costs at an amount greater than $50 million.*

Recommendation 13: The State should assist in finding a funding mechanism involving local cost sharing to investigate the needs for improvements to existing flood management infrastructures.

14. Standards for Community Rating System Points

Issue: *FEMA's National Flood Insurance Program (NFIP) recognizes community efforts that go beyond minimum standards by discounting flood insurance premiums from 5% up to 45% through the Community Rating System (CRS).These discounts provide an additional incentive for property owners to participate in the voluntary purchase of flood insurance. There is poor penetration of voluntary flood insurance in alluvial fan areas for a variety of reasons, including misconceptions about the likelihood of a "100-year flood," and the lack of recognition of the risk from smaller, more frequent floods. For communities seeking up to 100 points of CRS credit for regulating development on alluvial fans, credit is provided for regulating development in areas subject to alluvial fan hazards that account for the flood, sediment, erosion, debris, velocity, and avulsion hazards in the area. For alluvial fans, credit is the sum of the following:*

(1) 80 points, if all new structures are required to be protected from alluvial fan hazards;
(2) 10 points, if all utilities are required to be designed to function and minimize damage during the 100-year event; and
(3) 10 points, if access is required during the 100-year event.

For communities seeking CRS points, alternative language is provided in the Model Ordinance Governing Planning and Development on Alluvial Fans found in Chapter 9 of ***the Integrated Approach*** *document. The applicant for the proposed development would need to demonstrate that all new structures are required to be protected from alluvial fan hazards; all utilities are required to be designed to function and minimize damage during the 100-year event; and access to the development is adequate during the 100-year event.*

Recommendation 14: The State and FEMA should inform local officials and the public about the benefits of the NFIP Community Rating System (CRS) insurance–rate adjusting program.

Endnotes to Chapters 1-3

1 State of California 2007 Multi-Hazard Mitigation Plan, Chapter 5
2 Calculated from GIS dataset illustrated in Figure 1-1 of areas potentially containing alluvial fans
3 *Declining Rainwater Recharge in the Chino Basin Implications for the Watershed and Beyond,* Wildermuth Environmental Inc., January 29, 2009 Report to Chino Basin Watermaster
4 Ibid
5 2009 California Climate Adaptation Strategy Discussion Draft, California Resources Agency
6 Ibid
7 2009 California Climate Adaptation Strategy Discussion Draft, California Resources Agency
8 Ibid
9 Ibid
10 Alluvial Fans 150 Years of Flood Control, Urbanization, and Politics in Los Angeles, Los Angeles County Department of Public Works, Alluvial Fan Task Force Virtual Tour
11 Ibid
12 Ibid
13 Ibid
14 Ibid
15 Ibid
16 Ibid
17 Ibid
18 The Associated Press, February 23, 2010; Los Angeles Times, February 24, 2010
19 Ibid
20 Ibid
21 Ibid
22 *Economics and Alluvial Fans* and *Further Discussion of Economics of Alluvial Fans*, Dr. W. Bowman Cutter, Ph.D., Alluvial Fan Task Force Presentation, 3/14/2008
23 Ibid
24 California Floodplain Management Task Force Final Recommendations Report, Department of Water Resources, December 2002
25 Imperial, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Luis Obispo, Santa Barbara and Ventura from 2007 State Hazard Mitigation Plan, Chapter 5
26 2007 State Hazard Mitigation Plan, Chapter 5
27 French and Associates, LTD
28 Kusler, Jon and Larson, Larry, *Beyond the Ark: A New Approach to U.S. Floodplain Management,* Published in Environment, 6/1/1993

APPENDIX A

Assembly Bill 2141/ Assembly Bill 466

APPENDIX A
Assembly Bill 2141/ Assembly Bill 466

BILL NUMBER: AB 2141 CHAPTERED
BILL TEXT
CHAPTER 878
FILED WITH SECRETARY OF STATE SEPTEMBER 29, 2004
APPROVED BY GOVERNOR SEPTEMBER 29, 2004

INTRODUCED BY Assembly Member Longville

FEBRUARY 18, 2004

An act to add and repeal Part 10 (commencing with Section 12997) of Division 6 of the Water Code, relating to water.

LEGISLATIVE COUNSEL'S DIGEST

AB 2141, Longville. Floodplain management: Alluvial Fan Task Force.

Existing law authorizes the state to participate in flood control planning and provides for state cooperation with the federal government in the construction of flood control projects.
This bill would require the Director of Water Resources, on or before June 30, 2005, to establish the Alluvial Fan Task Force, with prescribed membership determined by the director, to review the state of knowledge regarding alluvial fan floodplains and to prepare recommendations relating to alluvial fan floodplain management. The bill would authorize the director to enter into an interagency agreement with an appropriate agency to oversee the task force. The bill would require the task force to develop a model ordinance on alluvial fan flooding. The bill would require the task force to prepare and submit a report to the Legislature not later than June 30, 2006. The bill would require these described duties to be carried out only to the extent funding is made available for those purposes from the federal government or private sources. The bill would prohibit the expenditure of state funds to carry out the bill's provisions. The bill would make related findings and declarations.

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1. The Legislature finds and declares all of the following:
(a) The impacts of alluvial fan flooding can be reduced by a better understanding of the public safety risks in alluvial fan floodplains.
(b) Alluvial fans present unique challenges to floodplain management.
(c) Alluvial fan flooding is unpredictable, given its geologic and geomorphic nature.
(d) The principal hazards associated with alluvial fan flooding are the high velocity and uncertainty of the quantity of debris-laden flows and the uncertainty of the flow paths in alluvial fan floodplains.
(e) Many of the alluvial fan floodplains in southern California have experienced development and are projected for additional development.
(f) As a result of the extensive fires in southern California in October 2003, the risk of debris flows from alluvial fan flooding in burned hillsides has increased dramatically.
(g) Alluvial fan flooding contributed to mudflows that took the lives of 16 people on Christmas Day in 2003.
(h) In recognition of the risk to people and property posed by the Christmas Day mudflows and potential

future mudflows, the federal disaster declaration for the southern California fires was amended to provide assistance to individuals, businesses, and public entities impacted by fire-related mudslides.

(i) Alluvial fan floodplains exist in the Counties of San Bernardino, Riverside, Los Angeles, Ventura, Santa Barbara, San Luis Obispo, Kern, Orange, Imperial, and San Diego.

(j) To prevent future loss of life and damage to property, it is important that alluvial fans throughout the state be accurately identified, and that landforms be evaluated to identify fan surfaces subject to flooding.

(k) The California Floodplain Management Task Force has recommended that the state establish an alluvial fan task force to review the state of knowledge regarding alluvial fan floodplains, determine future research needs, and, if appropriate, develop recommendations relating to alluvial fan floodplain management.

SEC. 2. Part 10 (commencing with Section 12997) is added to Division 6 of the Water Code, to read:

PART 10. ALLUVIAL FAN TASK FORCE

12997. (a) Not later than June 30, 2005, the director shall establish the Alluvial Fan Task Force with broad membership, to the maximum extent possible, from local, state, and federal government and other stakeholders to review the state of knowledge regarding alluvial fan floodplains, determine future research needs, and prepare recommendations relating to alluvial fan floodplain management, with an emphasis on alluvial fan floodplains that are being considered for development in accordance with local general plans. The director, in consultation with representatives of the Counties of San Bernardino, Riverside, Los Angeles, Ventura, Santa Barbara, San Luis Obispo, Kern, Orange, Imperial, and San Diego, may enter into an interagency agreement with the California State University, the University of California, or other appropriate agency to oversee the task force.

(b) The director shall determine the composition of the task force. The task force may include, but need not be limited to, representatives from all of the following entities or groups, subject to the consent of those entities or groups:

(1) City and county governments in the Counties of San Bernardino, Riverside, Los Angeles, Ventura, Santa Barbara, San Luis Obispo, Kern, Orange, Imperial, and San Diego.

(2) The department.

(3) Other local, state, and federal government agencies and stakeholders that represent relevant environmental, agricultural, and construction interests.

(c) The Alluvial Fan Task Force shall develop a model ordinance on alluvial fan flooding to be made available to communities subject to alluvial fan flooding.

(d) The Alluvial Fan Task Force shall prepare and submit a report, with findings and recommendations, to the Legislature not later than June 30, 2006.

12997.5. This part shall be carried out only to the extent funding is made available from the federal government or private sources to carry out this part. No state funds may be expended to carry out this part.

12998. This part shall remain in effect only until January 1, 2007, and as of that date is repealed, unless a later enacted statute, that is enacted before January 1, 2007, deletes or extends that date.

BILL NUMBER: AB 466 CHAPTERED

BILL TEXT RELATED TO ALLUVIAL FAN TASK FORCE ONLY
CHAPTER 567
FILED WITH SECRETARY OF STATE OCTOBER 6, 2005
APPROVED BY GOVERNOR OCTOBER 6, 2005

INTRODUCED BY Assembly Member Matthews
(Principal coauthor: Senator Speier)
(Coauthors: Assembly Members Cogdill and Yee)
(Coauthor: Senator Denham)

FEBRUARY 16, 2005

An act to amend Section 12997.5 of, and to add and repeal Section 79452.3 of, the Water Code, relating to natural resources, making an appropriation therefore, and declaring the urgency thereof, to take effect immediately.

LEGISLATIVE COUNSEL'S DIGEST

AB 466, Matthews. Natural resources: Department of Fish and Game: California Bay-Delta Authority.

Existing law requires the Alluvial Fan Task Force to develop a model ordinance on alluvial fan flooding to be made available to communities subject to alluvial fan flooding, and to prepare and submit a related report to the Legislature not later than June 30,
2006. Existing law prohibits the expenditure of state funds to carry out this program.

This bill would authorize the state to expend funds to carry out this program if state funds are used to provide a matching cost share, as required by the federal government for the use of federal funds.

This bill would declare that it is to take effect immediately as an urgency statute.

Appropriation: yes.

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1. Section 12997.5 of the Water Code is amended to read:

12997.5. This part shall be carried out only to the extent funding is made available from the federal government or private sources to carry out this part. The state may expend funds to carry out this part if the state funds are used to provide a matching cost share, as required by the federal government for the use of federal funds.

APPENDIX B

Alluvial Fan Task Force
Charter

APPENDIX B
Alluvial Fan Task Force Charter

This Charter describes the work of the AFTF including its history, purpose, roles of the parties, groundrules and the decision-making process. Changes to the charter maybe adopted with the concurrence of the members and sponsors, using the Charter decision-making process.

Background

An alluvial fan is a fan-shaped deposit formed at the base of semi-arid mountain ranges where fast flowing water flattens, slows, and spreads - typically at the exit of a canyon or mountain pass onto a flatter plain. Alluvial fans present special challenges for floodplain management. Principal hazards associated with alluvial fan flooding are high-velocity, debris-laden flows resulting from a series of storms, particularly following wildfires in semi-arid regions. Alluvial fan floodplains are found throughout California; however, they are most prevalent in the Counties of San Bernardino, Riverside, Los Angeles, Ventura, Santa Barbara, San Luis Obispo, Kern, Imperial, Orange, and San Diego.

The hillsides that regularly burn as a result of periodic Southern California wildfires create ideal conditions for post-fire debris flows on alluvial fans and downstream alluvial floodplains. On numerous occasions throughout California's history, foothill communities have suffered from property damage as tons of sediment and rock pour down the mountain channels, filling downstream creeks, debris basins, and flood control channels beyond their capacity flowing onto the alluvial floodplains. Post-fire flooding conditions remain elevated for up five years after a wildfire and the cycle repeats with the next wildfire. Alluvial fans are part of a larger system with flood risks that extend beyond the boundary of the fans.

Growth forecasts predict that communities located where alluvial fans are present may accommodate up to 60-percent of the new development occurring in Southern California in the 21st century. National attention on the cost of protecting lives and property from repetitive disasters have prompted the State of California and the federal government to look at measures that will reduce future flood damage and promote more "sustainable" local land-use decisions on floodplains.

California Floodplain Management Task Force Recognizes Need for AFTF

In 2000, Governor Gray Davis signed AB 1147, which recommended the creation of the California Floodplain Management Task Force. In February 2002, the Governor established the task force with broad membership from local, state and federal government and stakeholders with interest in flood management. The Final Task Force Report recommended strategies to reduce flood losses and maximize the benefit of floodplains. A copy of this report is included in the binder provided to each AFTF member.

Given the extent of growth projections on alluvial fans, the Floodplain Management Task Force specifically recommended that the State should convene an Alluvial Fan Task Force with the representation of vested stakeholders in Southern California to review the state of knowledge regarding alluvial fans floodplains and develop recommendations that would be specific to alluvial fan floodplain management.

Establishment of the Alluvial Fan Task Force (AFTF)

In 2004, following a tragic post-fire debris flow in San Bernardino County that took the lives of 16 Californians, Governor Schwarzenegger signed AB 2141. The bill directed the Department of Water Resources (DWR) to seek federal funding for the establishment of a stakeholder-driven Alluvial Fan Task Force to develop a Model Ordinance and planning tools as decision support for local governments that are entrusted with land-use authority.

DWR submitted an application to the Federal Emergency Management Agency (FEMA) and was awarded a Pre-Mitigation Disaster Planning Grant. In 2005, Governor Schwarzenegger signed AB 466 authorizing the State to expend funds to provide a matching cost share to the FEMA grant.

In March of 2007, DWR announced a partnership with California State University, San Bernardino's (CSUSB) Water Resources Institute to develop the AFTF under the direction of DWR staff. Following extensive interviews with elected officials, local flood districts, stormwater managers, water suppliers, water quality regulators, developers, development consultants, Native Americans, land-use advocates and the environmental community, DWR Director Lester Snow appointed 33 members to the AFTF joined by representatives from federal and state agencies.

Mission

The AFTF is charged with reviewing the state of knowledge of alluvial fans, examining the flood risks, and developing local planning tools, including a "Model Ordinance" and set of "Design Guidelines for Development on Alluvial Fans," aimed at reducing losses to human, built and natural resources resulting from the natural hazard of flooding on alluvial fans.

It will be pioneering work that will receive statewide and national attention for focusing attention on the special features and challenges of development on alluvial fans and recommending best practices to both reduce flood risks and sustain critical environmental assets. The AFTF will seek to close the gap between the actual flood risk (what the risk really is), the perceived flood risk (what decision makers and the public think the risk is) and the expected flood risk (what the decision makers and the public think the risk should be).

Geographic Scope

The geographic scope of the Task Force will be the 10 counties of Southern California - Los Angeles, Kern, San Bernardino, Riverside, Orange, San Diego, Imperial, Ventura and Santa Barbara, San Luis Obispo.

Methodology

The land use guidelines and model ordinance will be developed collaboratively by the members of the AFTF with the support of the DWR Management Team, the Water Resources Institute at CSUSB, and technical resource consultants and under the guidance of a professional facilitator.

1. Number of Plenary Sessions. The AFTF will hold seven plenary sessions between December 2007 and June 2008 to review information, consider options and develop recommendations for land use guidelines and a model ordinance.
2. How Meetings Will Be Conducted. Meetings will be convened by the AFTF Coordinator and run by a professional facilitator. Agendas will be discussed at prior meetings to give all AFTF members an opportunity to contribute to the agenda content. Meetings will be open to the public. Meetings are planned in communities affected by rapid growth on alluvial fans as projected by local governments through 2030.
3. Options for Work Groups. The AFTF has the option of creating smaller work groups to pursue topics in greater depth for the purpose of moving the AFTF's agenda forward. It will be up to the members of the AFTF to identify topics and select members for all work groups. The full group will be advised of any activities conducted by small groups.
4. Open Process. Meetings of the AFTF will be open to the public. Agendas will be sent out in advance of the meetings and posted on the AFTF web site. Observers are welcome to attend and are expected to adhere to the same groundrules as AFTF members.

Decision Making

The AFTF shall strive to reach consensus on all recommendations. Where possible, this will be achieved without traditional voting. When there is general agreement regarding a proposal, items will be moved forward; however, when necessary, the report will indicate the full range of perspectives, including minority opinions.

Throughout the process, in order to determine if the group is moving in a particular direction, the facilitator may also ask for an informal “read” of the group’s perspective. Answers to this type of facilitator’s request are used for the purpose of developing the dialogue and are not in anyway binding.

It is also understood that group members may represent organizations and are unable to make final commitments without the concurrence of a board or other body. In this case, agreements will be considered tentative pending approval. Such confirmation does not need to return to the group unless it affects the recommendation.

Meeting Schedule and Hosts

After checking availability of the appointees, seven full plenary meetings have been scheduled between December 2007 and June 2008. County Supervisors and local Flood Control Districts will be hosting the meetings in the communities of Southern California that will be most affected by future development on alluvial fans. Members will be notified of locations for each meeting as they are confirmed.
{Meeting Hosts and Locations Added}

- Plenary Meeting 1: December 7, 2007 - *Overview of Alluvial Fans*
  Host: Riverside County Flood Control District
  Location: Riverside, CA
- Plenary Meeting 2: January 4, 2008 - *Risks Factors on Alluvial Fans*
  Host: San Diego County Supervisor Bill Horn
  Location: Borrego Springs, CA
- Plenary Meeting 3: February 8, 2008 - *Development Issues on Alluvial Fans*
  Host: Los Angeles Supervisor Michael Antonovich
  Location: Lancaster, CA
- Plenary Meeting 4: March 14, 2008 - *Best Management Practices on Developed Alluvial Fans*
  Host: San Bernardino County Supervisor Paul Biane
  Location: Rialto, CA
- Plenary Meeting 5: April 11, 2008 – *Discuss Local Planning Tools and Model Ordinance*
  Host, Los Angeles County Supervisor Michael Antonovich
  Location: Los Angeles, CA
- Plenary Meeting 6: May 16, 2008 – *Continue to Discuss Local Planning Tools and Model Ordinance*
  Host: Coachella Valley Water District
  Location: Riverside, CA
- Plenary Meeting 7: June 6, 2008 – *Seek Consensus on Local Planning Tools*
  Host: Kern County Supervisor Jon McQuiston
  Location: Bakersfield, CA
- Plenary Meeting 8: **September 19, 2008**- *Continue to Discuss Model Ordinance*
  Host: **Riverside County Flood Control and Water Conservation District**
  Location: Riverside, CA
- Plenary Meeting 9: **March 27, 2009-** *Continue to Seek Consensus on Local Planning Tools, Model Ordinance and Findings and Recommendations*
  Host: Metropolitan Water District of Southern California
  Location: Los Angeles, CA

- Plenary Meeting 10: **March 19, 2010** - *Final Consensus The Integrated Approach for Sustainable Development on Alluvial Fans containing the pre-project screening and flood management tools and AFTF Findings and Recommendations Report*

  Host: The Frontier Project at Cucamonga Valley Water District

  Location: Rancho Cucamonga, CA

Roles

Roles in the AFTF will include: Executive Sponsor (Department of Water Resources), Administrative Sponsor (Water Resources Institute), Task Force Members, State and Federal Representatives, Resource/Technical Experts, Coordinator, Facilitator, and Observers

Specific tasks and responsibilities for different roles include:

<u>DWR (Executive Sponsor)</u>

1. Function as the host agency under the executive leadership of Director Lester Snow.
2. Foster the full participation of all state and federal agency representatives that should be included in the AFTF.
3. Conduct management team discussions regarding the work of the AFTF.
4. Provide the executive officer, staff and consultant support to the AFTF.
5. Chair meetings under the leadership of DWR Director Lester Snow.
6. Serve as a peer and one of many voices during the meeting process.
7. Submit Final Report including final policy recommendations to FEMA and the Legislature

<u>Water Resources Institute at CSUSB (Administrative Coordinator)</u>

1. Coordinate and manage all activities of the AFTF including contractual agreements with technical consultants.
2. Arrange meeting logistics and determine meeting content necessary to complete the products and deliverables of the AFTF.
3. Serve as a "clearinghouse" for information and release all documents for consideration by the AFTF members.
4. Develop and maintain a secure password-protected website for members and distribute public information regarding the AFTF to stakeholder groups and the members of the media.
5. Develop text and format for the final policy recommendations.
6. Submit the final report including final policy recommendations to DWR which in turn is submitted to FEMA and the Legislature
7. Transmit AFTF recommendations to County and City Governments.

<u>The AFTF Members</u>

1. Provide diverse perspectives, representing a broad scope of those impacted by alluvial fan development so that policy, to the fullest extent possible and meeting the needs and interests of the citizens of Southern California and its natural environment.
2. Review and provide recommendations on planning guidelines and a model ordinance.
3. Be full participants (includes representatives and designees).
4. Help identify, review, verify and critique data, assumptions, analysis and methods related to development on alluvial fans.
5. Communicate to the broader public, as well as the individual constituencies and communities represented by each individual member, information about the process and products of the AFTF.
6. Seek consensus.
7. Serve as advocates and experts on the benefits afforded by the adoption of the Model Ordinance and Design Guidelines for Development on Alluvial Fans by County Board of Supervisors, City Councils and Planning Commissions.

State and Federal Agency Representatives

1. Are expected to participate as full members of the AFTF.
2. Assure that the products and deliverables of the AFTF can be implemented effectively at all levels of government.

The Facilitator

1. Serves as professional neutral responsible for managing dialogue in meetings and overseeing the provisions of the group charter.
2. Designs, implements and refines, as needed a consensus-seeking process.
3. Facilitates AFTF meeting and related work team meetings as necessary.
4. Ensures that all points of view held by the AFTF members are heard and that the interests of each member's constituencies are considered.
5. Acts as a professional neutral in the relationship among the AFTF members and between the AFTF and DWR and other State and Federal representatives.
6. Acts as a professional neutral in terms of the outcome of the AFTF's work product.

Technical Consultants

1. Assemble technical information as directed by the Coordinator that is relevant to the outcomes expected of the AFTF.
2. Provide accessible educational presentations at the AFTF plenary sessions.
3. Provide a range of options to the members of the AFTF for consideration in the Model Ordinance and Design Guidelines for Development on Alluvial Fans and continue to work with the Coordinator and members to refine the products and deliverables throughout the process
4. Be available to work with AFTF members on specific areas of interest.
5. Submit final reports as identified in Task Orders by the Coordinator for inclusion in the final AFTF report.

Values and Principles

This is a consensus seeking, collaborative process. Because this process addresses a complex public policy issue, it will take many months to complete. Participants agree to:

- *Accept the AFTF mission, scope and methodology.*
- *Establish a common factual base and vocabulary in order to address issues of common concern.*
- *Develop a thorough understanding not only of their own interests but also the interests of the other par ties at the table.*
- *Negotiate satisfactory and realistic agreements, which satisfy as many of the varied interests as possible. It is understood that all the parties must continue to operate under their own guidelines and timetables. As such, some members may need to take action related to those requirements that could have a negative impact on the discussions taking place. Even so, members agree to work in good faith within the process.*

Groundrules

The group will use standing groundrules regarding meeting protocol and may modify them as appropriate. The group agrees to:

- *Come with an open mind, and respect for others' interests and differing opinions.*
- *Treat one another with courtesy.*
- *Let one person speak at a time.*
- *Be honest, fair, and as candid as possible.*
- *Think outside the box and welcome new ideas.*
- *Respect time constraints, be succinct.*
- *View disagreements as problems to be solved rather than battles to be won.*

- *Respect that AFTF members may talk with the media at any time, but will represent only their own perspective and not to speak for any other member or the AFTF as a whole.*

AFTF Member Ground Rules for Media Contact

When discussing the recommendations or negotiations with anyone outside of the AFTF, members may relate the history and purpose of the AFTF, the problem statement, the list of participating Stakeholder Groups, and the general underlying interests, which have been expressed. In addition, members may discuss more specific aspects of the recommendations or negotiations, and in so doing, shall be careful to present only their own views and not characterize the motivations or values of any other member or Stakeholder Group. AFTF members shall avoid the temptation to quote other members, attribute comments to other members, or discuss other members' statements or positions.

Attendance

Given the volume of information to be considered and the short time frame, regular attendance by the member or his/her designated representative is essential. If an AFTF member is unable to attend a meeting, a designee must be identified in advance, fully briefed and able to represent the member during a meeting including any decision making.

Communication During AFTF Process

The Water Resources Institute will provide minutes of the AFTF meetings to Task Force members within 10 days of a meeting.
Constituents - Task Force members will be responsible for sharing information related to the AFTF with their respective constituents and for bringing forth issues and options from their constituents to all AFTF members.
Media – All media briefing materials will be prepared and distributed by the AFTF Coordinator after approval by DWR.
Decision-Makers – Key decision makers will be kept informed through written correspondence and formal briefings.
Public – The public is welcome to attend all AFTF meetings. The Coordinator and Facilitator will be available to provide presentations of the group's work at meetings, conferences or other forums. AFTF members are strongly encouraged to provide presentations about the group's work wherever feasible to increase awareness of the AFTF's work. Press kits and media releases will be available to the members.

Products and Deliverables

Based on the work of the AFTF the Water Resources Institute at CSUSB will deliver a report containing the land use guidelines and a model ordinance for future development on alluvial fans in the 10 counties of Southern California to the Department of Natural Resources before December 15, 2008.

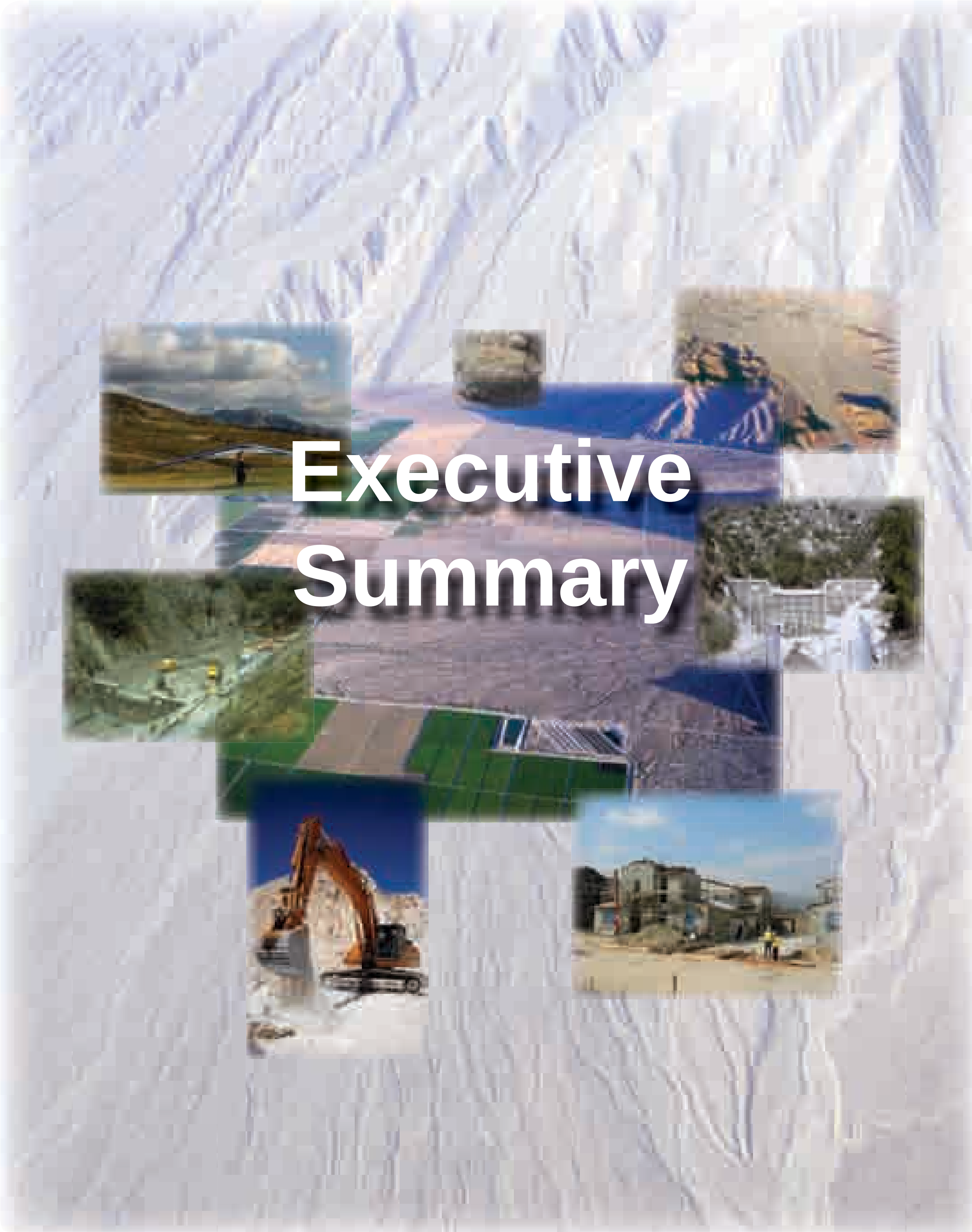
DWR will review and forward the report to the State Legislature and release it to the public. In addition to developing recommendations, products will include GIS maps of alluvial fans, videoed educational presentations, briefing memos, academic literature references, and reports from technical resource consultants. It is the intent of the AFTF that planning tools should be adopted locally.

APPENDIX C

Executive Summary
for the

Integrated Approach
for Sustainable Development
on Alluvial Fans

Executive Summary



EXECUTIVE SUMMARY

The Integrated Approach for Sustainable Development on Alluvial Fans (*Integrated Approach or IA)* was developed by the Alluvial Fan Task Force (Task Force or AFTF); a collaborative stakeholder-driven effort including elected officials, local floodplain managers, developers, environmental interests and representatives from related state and federal agencies. The Task Force was established by the Governor and the Legislature in 2004 pursuant to Assembly Bill (AB) 2141 and convened by the Department of Water Resources (DWR) in December of 2007 when funding from a Pre-Disaster Mitigation Planning Grant from the Federal Emergency Management Agency (FEMA) and a state match were authorized by AB 466.

The members of the Task Force were charged with examining issues related to the unique flood hazards associated with development on alluvial fans. An alluvial fan is formed where fast-flowing water flattens, slows, and spreads onto a plain – typically at the exit of a canyon or mountain pass. Principal hazards associated with alluvial fan flooding include high-velocity, debris-laden flows resulting from a series of storms, particularly following wildfires, in semi-arid regions. Efforts were focused on a Southern California study area consisting of Imperial, Kern, Los Angeles, Orange, Riverside, Ventura, San Bernardino, San Diego, Santa Barbara, and Ventura counties where alluvial fans are present.

The *The Integrated Approach* acknowledges the complex nature of alluvial fans and is designed to support sustainable integrated resource, land use and floodplain management planning of alluvial fans. The methods encourage being smart up front, looking at the integrated nature of hazards and resources and not just the pieces, assessing risks and avoiding them as much as possible, putting sustainable financing and insurance programs in place to deal with long-term costs, and developing integrated approaches that provide multiple benefits regionally.

Landowners, developers, local government agencies and other reviewers, flood managers, the environmental community and other stakeholders face special challenges when development occurs on alluvial fans. That is because alluvial fans are dynamic and each one is unique with its own signature of hazards that may be present. This makes a one-size-fits-all management approach ineffective.

Since 1950, all 10 counties in the study area where alluvial fans are present have been declared flood disaster areas at least three times. [1] Since 1992, every county in California has been declared a federal disaster area at least once for a flooding event.[2] Nationally, flood insurance claims in areas outside the mapped "100-year" floodplain account for 31 percent of the claims paid for flood damage.[3] Post-disaster recovery costs in California have reached almost $7 billion dollars from flooding and wildfire alone since 1950[4] which reflects only a fraction of the total disaster losses. Disasters and corresponding losses have grown exponentially in Southern California as the number of people and structures located in areas of risk have increased.

Alluvial fans are increasingly being seen as local resources for the multiple benefits they provide which include groundwater recharge, critical habitat, ecological connectivity, open space, aesthetic beauty and recreation as well as future development sites. Most undeveloped alluvial fans have the innate capacity to capture the ephemeral flow of rainwater that helps to recharge local groundwater basins. Southern California's capacity to retain historic rainwater recharge helps ease dependency on imported water supplies for the region.

Single-purpose flood management infrastructure for hazard protection was the predominant approach to accommodating alluvial fan development in the past. This approach was dependent upon a flood management system comprised of levees, debris basins, and hardened channels that captured water and sediment and conveyed it away from areas of risk to prevent property damage. While this approach of flood management has been effective at managing flood risk, it has created significant water resource impacts. Extensive systems of concrete flood channels throughout Southern California have resulted in the loss of riparian and wetland habitats, water quality problems in streams and at the beach, groundwater recharge losses, and communities whose physical character is dominated by concrete channels. The preferred approach today is to integrate flood management with land use that conserves the beneficial values provided by alluvial fans through locally cost-effective sustainable development strategies.

The *Integrated Approach* provides a suite of pre-project screening tools designed to assist stakeholders in identifying potential hazards and benefits associated with individual alluvial fan sites to minimize flood risks and other hazards and conserve beneficial resource values, such as ground water recharge, critical habitat, mineral resources and scenic beauty. Sustainable development on alluvial fans—which seeks to meet today's needs without prejudicing the ability of future generations to meet their own needs— rests on preserving ecological and financial sustainability. This is consistent with DWR's FloodSAFE vision "that improves public safety, protects and enhances environmental and cultural resources, and supports economic growth by reducing the probability of destructive floods, promoting beneficial floodplain processes, and lowering the damages caused by flooding."

Who should use the *Integrated Approach* and for what purpose?

- **Cities and counties** should use the *Integrated Approach* for planning and evaluating the suitability of alluvial fans for development in light of long-term ecological and financial sustainability issues facing the region.
- **Developers and property owners** should use the *Integrated Approach* for investigating sustainable uses of alluvial fan assets and working effectively with public agencies.
- **Environmental groups** should use the *Integrated Approach* for planning the conservation of alluvial fans as open space to protect critical habitat of threatened and endangered species, scenic beauty, recreational uses and future water supply reliability.
- **Water agencies** should use the Integrated Approach for developing integrated regional water management partnerships that helps retain historic rainwater infiltration on undeveloped alluvial fans for local groundwater recharge.
- **Local flood managers** should use the *Integrated Approach* as a resource for working with cities and counties, developers and property owners, environmental groups and water agencies on alluvial fan land uses in a collaborative fashion that increases the capacity of current alluvial fan floodplain management systems.

The *Integrated Approach* contains nine chapters that are briefly described below.

Chapter 1 describes in greater details the issues associated with development on alluvial fans and provides an overview of the *Integrated Approach* process.

Chapter 2 contains the pre-project screening tools in Step 1 that are labeled FZ 1-2 (Flood Zone). The FZ tools provide methods to determine whether a potential development site is within a FEMA-designated Special Flood Hazard Area (SFHA) and whether the site is located in an area with existing flood control structures that may adequately provide flood hazard protection.

Chapter 3 contains the pre-project screening tools in Step 2 that are labeled AF 1-2 (Alluvial Fan). The AF tools provide methods to identify the general distribution of alluvial fans, and qualitatively evaluate the relative potential alluvial for fan flooding at a site.

Chapter 4 contains the pre-project screening tools in Step 3 that are labeled MH 1-6 (Multiple Hazards). The MH tools provide methods to evaluate the presence of other hazards (i.e., non-flood hazards), such as seismic or wildfire risks, often present in alluvial fan areas.

Chapter 5 contains the pre-project screening tools in Step 4 that are labeled MB 1-5 (Multiple Benefits). The MB tools provide methods to identify the beneficial values that are provided in an alluvial fan area.

Chapter 6 contains the pre-project screening tools in Step 5 that are labeled SA 1-2 (Sustainability Analysis). The SA tools provide methods to determine capacity and suitability of alluvial fan sites and help identify multiple objectives that can be incorporated that are consistent with DWR's FloodSAFE vision.

Chapter 7 contains the tools in Step 6 that are labeled ECON 1-7 (Economic). The ECON tools provide methods to formulate economic strategies for sustainable development on alluvial fans that acknowledge private property rights and local cost-effectiveness. Included are suggestions for incorporating alluvial fan management objectives in Integrated Regional Water Management (IRWM) Plans.

Chapter 8 describes flood management tools consistent with FEMA guidelines to analyze alluvial fan flood hazards and to formulate flood hazard protection, and to incorporate multiple objectives into protection measures for projects in an alluvial fan area. There are six Flood Management tools labeled FM 1-6 developed by the Task Force.

Chapter 9 provides the Model Ordinance Governing Planning and Development on Alluvial Fans that was developed by the Task Force as directed by the Governor and Legislature pursuant to AB 2141. Cities and counties with alluvial fans located within their jurisdictions may voluntarily adopt this Model Ordinance adapting as needed to meet local needs.

Endnotes

1 California Floodplain Management Task Force Final Report, Department of Water Resources, December 2002

2 2007 State Hazard Mitigation Plan, Chapter 4

3 Kusler, Jon and Larson, Larry, Beyond the Ark: *A New Approach to U.S. Floodplain Management,* Published in Environment, 6/1/1993

4 Disaster Emergencies, Casualties, and Costs by Type, 1950-2007 (2007 State of California Hazard Mitigation Plan)

Disaster Type	Number of Events	State Disaster Proclamations	Federal Disaster Declararations	Deaths	Injuries	State-administered Costs
Wildfire	128	61	86	97	1,504	$2,092,991,622
Flood	120	111	45	292	759	4,813,564,327

APPENDIX D

DRAFT
MODEL ORDINANCE

MODEL ORDINANCE GOVERNING PLANNING AND DEVELOPMENT ON ALLUVIAL FANS

Preface

To implement the local planning tools presented in the Integrated Approach, the AFTF has developed a Model Ordinance (MO) that cities and counties with alluvial fans located within their jurisdictions may consider for local adoption.

The MO is designed to lead to better informed land use decisions for planning and development on alluvial fans. In particular, the MO is designed to ensure that such land use decisions achieve three critically important objectives: (1) to minimize flooding and other hazards that are posed by locating development on alluvial fans; (2) to minimize the costs and damages that may result from these hazards; and (3) to preserve and maximize the flood protection, environmental and other beneficial values that alluvial fans provide. To that end, the MO sets forth procedures to be followed, and substantive factors to be considered, for local land use decisions involving alluvial fan areas, including both planning-level decisions associated with periodic General Plan updates and project-level decisions for individual development projects as they are proposed. The ultimate goal is for local communities to utilize the best available scientific information to ensure that planning and development on alluvial fans are smart, safe and sustainable.

Local communities may, at their discretion, adopt the MO or revise it as appropriate to suit local needs and conditions. For instance, local communities may decide to broaden, or narrow, the types of land use decisions or proposed development projects that are subject to the ordinance. Local communities may also decide to change the threshold dividing those types of development projects that are subject to a full review of alluvial fan issues, and those types of projects that may be reviewed through a more streamlined process. There is also an optional provision provided for communities seeking discounted flood insurance premiums for property owners through participation in the Community Rating System (CRS) which recognizes efforts that go beyond minimum standards. Discounted premiums provide an additional incentive to participate in the voluntary purchase of flood insurance through FEMA's National Flood Insurance Program (NFIP).

In all cases, local communities are encouraged to consider and utilize the local planning tools as early as possible in the land use planning process, with the aim of promoting decisions that take into account the unique hazards and benefits posed by the particular alluvial fan at issue. The Task Force intends that the following Model Ordinance be a flexible model that local governments can adapt to their own conditions to meet local needs.

SECTION 1.0
STATUTORY AUTHORIZATION, FINDINGS AND PURPOSE

1.1 STATUTORY AUTHORIZATION

Article XI, Section 7, of the California Constitution confers upon local governments the authority to adopt ordinances and regulations that are designed to promote the public health, safety, and general welfare of their citizenry. In accordance with its constitutional police powers, the [*governing body*] of [*name of city or county*] does hereby adopt the following ordinance governing land use decision-making for sites located on an alluvial fan.

1.2 FINDINGS

The [*governing body*] of [*name of city or county*] hereby finds as follows:

A. Alluvial fans are dynamic landscapes that can pose serious flooding and other hazards. Alluvial fan flooding is difficult to predict, and is often fast-flowing and accompanied by substantial debris flows. Other potential hazards associated with alluvial fans include wildfires, erosion, collapsible soils and seismic hazards.

B. The various hazards associated with alluvial fans can cause serious risks to public health and safety and extensive damage to property, buildings and infrastructure. As a result, alluvial fan hazards can result in significant costs to public agencies and communities where alluvial fans are located.

C. Alluvial fans also provide multiple benefits by supporting valuable floodplain management, ecological, environmental, geological, hydrological, open space and aesthetic resources.

D. Alluvial fans present a significant challenge for public agencies and local communities because they often present prime opportunities for development. Alluvial fans typically offer premium building sites near mountainous areas that provide recreational opportunities and excellent views.

E. Many of the alluvial fans in Southern California have experienced development and alluvial fans will continue to be developed for the foreseeable future. Alluvial fans exist within [*name of city or county*].

F. Alluvial fans are comprised of a mosaic of surfaces that include geologically and hydrologically active or inactive surfaces that provide diverse benefits and pose differing risks to people and property.

G. Local agencies should strive to manage development on alluvial fans in a safe and environmentally sustainable manner by considering the dynamic and often hazardous nature of alluvial fans, the multiple benefits provided by alluvial fans, the scientific information and resources that have been developed concerning alluvial fans, unique local conditions, and the needs of the local community.

H. [*Name of city or county*] has land use authority over the use and development of land located on alluvial fans within its jurisdiction, including the power to specify the procedures and considerations for evaluating proposed development on alluvial fans and the power to require measures to minimize the potential flooding and other hazards posed by locating development on an alluvial fan.

I. The California Alluvial Fan Task Force has developed a detailed set of planning tools and approaches ("***AFTF Local Planning Tools***") that local agencies may use when planning for the use and development of land located on alluvial fans. The AFTF Local Planning Tools have been approved by the California Department of Water Resources and are publicly available in a document entitled *The Integrated Approach for Hazard and Resource Evaluation for Sustainable Development on Alluvial Fans* ("***AFTF Integrated Approach***"). The AFTF Local Planning Tools provide valuable guidance and suggested methodologies for assessing the flooding and other hazards that may be posed by locating development on alluvial fans; assessing the environmental and other benefits provided by preserving alluvial fans in their natural state; identifying practices for reducing alluvial fan hazards and maximizing alluvial fan beneficial values; and assessing the long-term economic impacts associated with locating development on alluvial fans. The AFTF Local Planning Tools present a broad suite of options that local communities may use when faced with the challenges that alluvial fans present.

J. The AFTF Integrated Approach is consistent with the California Department of Water Resources FloodSAFE vision for "a sustainable integrated flood management and emergency response system throughout California that improves public safety, protects and enhances environmental and cultural resources, and supports economic growth by reducing the probability of destructive floods, promoting beneficial floodplain processes, and lowering the damages caused by flooding."

1.3 STATEMENT OF PURPOSE

It is the purpose of this ordinance to promote the public health, safety, and general welfare by directing the management of alluvial fans in a manner that considers the multiple hazards that may be posed by locating development on alluvial fans, the multiple benefits provided by alluvial fans, unique local conditions, and the scientific tools and resources that have been developed concerning alluvial fans. In accordance with this overarching purpose, this ordinance establishes the procedures and considerations for planning for, evaluating and managing the use and development of land located on alluvial fans within the jurisdiction of [*name of city or county*]. The ordinance is designed to achieve the following goals:

A. To protect human life and health.

B. To minimize the costs posed by alluvial fan hazards, including the risks of damage to public and private property, utilities and other infrastructure located on alluvial fans, such as water and gas mains; canals; electric, telephone and sewer lines; and streets, highways and bridges.

C. To minimize the need for rescue, flood-fighting, relief and rehabilitation efforts associated with alluvial fan flooding and the associated expense to the general public.

D. To minimize prolonged business interruptions and loss of residential occupancy that may result from the hazards posed by locating development on alluvial fans.

E. To provide notice to potential purchasers of property located on alluvial fans that the property is in an area that may be subject to flooding or other potential hazards.

F. To promote the sustainability of resources by maximizing and conserving to the extent feasible the benefits provided by alluvial fans.

G. To provide a framework for property owners to develop land located on alluvial fans in a safe and sustainable manner.

H. To balance the benefits provided by alluvial fans with the benefits provided by new development.

I. To establish a process to identify the costs and hazards associated with locating development on alluvial fans and the possible methods for addressing these costs and hazards, in order to guide informed decision-making concerning the use and development of lands located on alluvial fans.

SECTION 2.0
DEFINITIONS

Unless specifically defined below, words or phrases used in this ordinance shall be interpreted so as to give them the meaning they have in common usage and to give this ordinance its most reasonable application.

"***Active Alluvial Fan Flooding***" is flooding that occurs only on alluvial fans and is characterized by flow path uncertainty so great that this uncertainty cannot be set aside in realistic assessments of flood risk or in the reliable mitigation of the hazard. An active alluvial fan flooding hazard is indicated by three related criteria: (1) flow path uncertainty below the hydrographic apex; (2) abrupt deposition and ensuing erosion of sediment as a stream or debris flow loses its ability to carry material eroded from a steeper, upstream source area; and (3) an environment where the combination of sediment availability, slope, and topography creates an ultra-hazardous condition for which elevation on fill will not reliably mitigate the risk.

"***Alluvial fan beneficial values***" are the floodplain management, ecological, environmental, geological, hydrological, groundwater recharge, open space, aesthetic and other positive values attributed to the preservation of areas that are located on alluvial fans.

"***Alluvial fan flooding***" is a type of flooding that occurs only on alluvial fans. It encompasses both "active alluvial fan flooding" and "inactive alluvial fan flooding" and can include distributary flow, sheet flow, and sheet flooding.

"***Alluvial fan hazards***" refers to the potential for flooding and other threats to life, property and safety that may occur when development is located on an alluvial fan.

The "***Alluvial Fan Task Force***" or "***California Alluvial Fan Task Force***" (or "***AFTF***") was established pursuant to California Assembly Bill 2141 (2004) under the auspices of the California Department of Water Resources. The AFTF includes officials from state and federal public agencies, local government representatives, flood control and floodplain managers, representatives of the development community, land use advocates and various at-large members. The AFTF study area covers the Counties of Los Angeles, Kern, San Bernardino, Riverside, Orange, San Diego, Imperial, Ventura, Santa Barbara and San Luis Obispo. The mission of the AFTF has been to review the current state of the knowledge about alluvial fans and to develop local planning tools aimed at reducing alluvial fan hazards and promoting alluvial fan beneficial values.

The “***Alluvial Fan Task Force Integrated Approach***” (“***AFTF Integrated Approach***”) is a catalogue of information and methodologies designed for local agencies to utilize when planning for, evaluating and managing the use and development of areas located on alluvial fans within their jurisdiction. It is officially entitled “*An Integrated Approach for Evaluating Hazards and Beneficial Floodplain Values for Sustainable Development on Alluvial Fans*.” It reflects the current knowledge about alluvial fans, alluvial fan beneficial values, and alluvial fan hazards. The AFTF Integrated Approach identifies planning tools and approaches (the “***AFTF Local Planning Tools***”) that may be used to minimize risks to life and property from alluvial fan hazards and to protect and maximize alluvial fan beneficial values. The AFTF Integrated Approach was prepared by the California Alluvial Fan Task Force pursuant to California Assembly Bill 2141 (2004). It is [on file at *address: e.g., City Hall, County Administration Building, Department of Planning or Public Works, etc.*] [Attached to this ordinance as Appendix A] [Posted on the California Department of Water Resources’ website at (insert URL)].

“***Building***” - see “***Structure***”

“***Clast***” means an individual constituent, grain or fragment of sediment or rock, produced by the mechanical or chemical weathering (i.e., disintegration) of a larger rock mass.

“***Debris flow***” is a mix of water and debris, which may include clasts ranging in size from clay particles to boulders and may contain abundant woody debris and other materials, that flows down a stream channel or steep slope, sometimes at great velocity, and contains more than 60 percent debris (less than 40 percent water) by volume.

“***Desert varnish***” is a thin, dark, shiny film or coating formed on the surfaces of clasts resulting from long-term exposure to an arid climate.

“***Development***” means any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations or storage of equipment or materials.

“***Distributary flow***” consists of a diffuse flow where there is a distinct channel fork at an out flowing branch of a stream. Areas with distributary flow typically are composed of channel forks, joins and outlets. Active alluvial fans typically are characterized by distributary flow.

“***Engineered Control Structure***” is an engineered structure, such as a dam or debris basin, that is designed to minimize the risks posed by alluvial fan flooding, for example, by restricting the flow of runoff from the upland watershed onto the alluvial fan, or by preventing flooding on an alluvial fan from leaving a designed flow channel.

“***FEMA***” means the Federal Emergency Management Agency.

“***Flood***” or “***flooding***” means a general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters or (2) the unusual and rapid accumulation or runoff of surface waters from any source.

“***Governing body***” is the local governing unit (*i.e.*, county or municipality) that is empowered to adopt and implement rules and regulations to provide for the public health, safety and general welfare of its citizenry.

“***Hydrographic apex***” means the head or highest point on an active alluvial fan.

“***Hyper-concentrated flow***” is a moving mixture of sediment and water containing between 20 and 60 percent sediment by volume.

“***Inactive alluvial fan flooding***” refers to flooding that is similar to traditional riverine flood hazards, but occurs only on alluvial fans. Inactive alluvial fan flooding is characterized by flow paths with a higher degree of certainty in realistic assessments of flood risk or in the reliable mitigation of the hazard. Unlike active alluvial fan flooding hazards, an inactive alluvial fan flooding hazard is characterized by relatively stable flow paths. However, like areas of active alluvial fan flooding, inactive alluvial fan flooding, may be subject to sediment deposition and erosion, but to a degree that does not cause flow path instability and uncertainty.

“***Local administrator***” is the individual that is designated by [*name of city or county*] to administer and enforce the provisions of this ordinance.

“***Riverine***” means pertaining to or formed by a river.

“***Sediment***” refers to fragmental material that originates from the weathering of rocks, and is transported by, suspended in, or deposited by water or air, or is accumulated in beds by other natural occurrences such as the evaporation of saline water.

“***Sheet flood***” refers to a broad expanse of moving, storm-borne water that spreads as a thin, continuous, relatively uniform film over a large area in an arid region and that is not concentrated into well defined channels; its distance of flow is short and its duration is measured in minutes or hours.

“***Sheet Flow***” refers to an overland flow or down slope movement of water taking the form of a thin, continuous film over relatively smooth soil or rock surfaces and not concentrated into channels larger than rills. This flow typically is short lived with a limited travel distance. Most surface runoff starts as overland flow and commonly enters rills before it concentrates in channels. Natural overland flow is characterized by several lateral down slope concentrations of flow rather than uniform sheet flow.

“***Structure***” means a walled and roofed building that is substantially above ground.

“***Sustainability***” or “***sustainable development***” refers to development that meets the needs of the present, while using natural resources including land, water, and energy in a way that does not compromise the ability of future generations to meet their own needs.

“***Uncertain flow path***” means that the perceived, historical channel or network of channels cannot be relied on to convey a base flood without the creation of new flow paths or the abandonment of existing flow paths.

SECTION 3.0
GENERAL PROVISIONS

3.1 DESIGNATION OF LOCAL ADMINISTRATOR

The [*City Manager, Planning Director, Public Works Director, Building Official, etc.*] is hereby designated by the [*name of city or county*] to administer, implement and enforce the provisions of this ordinance.

3.2 CONSULTATION WITH FLOOD OFFICIALS AND USE OF THE AFTF INTEGRATED APPROACH AND LOCAL PLANNING TOOLS

(a) In fulfilling the provisions of this ordinance, the Local Administrator shall to the extent feasible consult with any local agencies or officials with responsibility for flood management and protection in [*name of city or county*].

(b) In fulfilling the provisions of this ordinance, the Local Administrator is authorized to rely upon the sources of information and the planning tools and approaches that are outlined in the AFTF Integrated Approach. Specific provisions contained in the AFTF Integrated Approach include the following Local Planning Tools:

(1) Identify whether proposed site is on a regulated floodplain with adequate flood protection (*Tool FZ1*–identify if the site is located within FEMA special flood hazard area; *Tool FZ2*–identify the presence of existing flood control structures)

(2) Consider relative flood hazard potential (*Tool AF1*–identify if the site is in an area underlain by quaternary age alluvial sediments; *Tool AF2*–map the general distribution and relative potential for alluvial fan flooding).

(3) Consider other hazards present on proposed site (*Tool MH1*–map zones prone to surface rupture of active faults; *Tool MB2*– identify ecologically valuable areas; *Tool MB3*– identify mineral resources; *Tool MB4*– identify culturally significant zones; *Tool MB5*– identify current and future uses).

(4) Consider beneficial resources on proposed site (*Tool MB1*– identify recharge areas; *Tool MB2*– consider the site's seismic shaking potential; *Tool MH3*–identify landslide and rockfall hazard potential; *Tool MH4*–identify presence of hazardous minerals, unstable geological units and hazardous materials; *Tool MH5*–delineate potential wildfire hazards; *Tool MH6*–delineate other hazards identified by local agencies).

(5) Consider capacity to address multiple objectives consistent with FloodSAFE (*Tool SA1*– examine capability of site for proposed use; *Tool SA2*– examine suitability of site for proposed use).

(6) Consider problem-solving economic strategies (*Tool ECON1- multiple-benefit IRWM projects; Tool ECON2*–perform a cost-benefit analysis; *Tool ECON3*–examine resources for economic management; *Tool ECON4*–examine public or private transfers or purchases of development rights; *Tool ECON5*–identify other funds for financial assistance; *Tool ECON6*–develop cost-effective clean-up procedures; and *Tool ECON7*–examine the asset management plan for flood management infrastructure).

(7) Consider flood management tools (*Tool FM1*– identify the presence of an alluvial fan; *Tool FM2*– identify existing hazards on alluvial fan areas; *Tool FM3* define the active and inactive areas of a fan; *Tool FM4*– establish the appropriate level of hazard protection; *Tool FM5*– identify the studies necessary to demonstrate that the proposed project would be protected from the design flood; and *Tool FM6*– incorporate multiple objectives into the mitigation measures).

(c) In fulfilling the provisions of this ordinance, the Local Administrator is also authorized to rely upon any additional relevant information pertaining to alluvial fans.

3.3 RELATIONSHIP TO OTHER LAWS

(a) This ordinance is not intended to supersede, repeal, abrogate, or impair any existing law, regulation, ordinance or resolution. However, where this ordinance and another law, regulation, ordinance or resolution overlap, whichever imposes the more stringent requirements shall prevail.

(b) This ordinance is not intended to duplicate, expand or replace other legal requirements that may be applicable with respect to the use and development of land that is located, in whole or in part, on an alluvial fan. Such other legal requirements under State law may include, for example, applicable provisions in the California Fish & Game Code; the California Water Code; the California Environmental Quality Act; the California Building Code; and other California laws and regulations governing public health and safety, geologic or seismic hazards, hazardous substances, or land use planning and zoning. Such other legal requirements under Federal law may include, for example, applicable provisions of the Endangered Species Act; the Clean Water Act; and federal regulations promulgated by FEMA to govern the provision of flood insurance. However, in fulfilling the provisions of this ordinance, the Local Administrator may review and rely upon any relevant studies or information prepared pursuant to these other legal requirements.

3.4 INTERPRETATION

In the interpretation and application of this ordinance, all provisions shall be liberally construed in favor of [*name of city or county*], and deemed neither to limit nor repeal any other powers granted to [*name of city or county*] by the California Constitution or the statutes of this State.

3.5 WARNING AND DISCLAIMER OF LIABILITY

Even with the adoption and implementation of this ordinance, alluvial fan hazards will continue to exist. This ordinance is not meant to imply that land uses that are permitted on an alluvial fan will be free from alluvial fan hazards or from damages resulting from such hazards. This ordinance shall not create any liability on the part [*name of city or county*], any of its officers or employees, the State of California, or the federal government, for any flood or other damages that may result from reliance on this ordinance or on any administrative decision lawfully made under this ordinance.

3.6 SEVERABILITY

This ordinance and the various parts of it are severable. Should any section of this ordinance be declared by a court of law to be unconstitutional or otherwise invalid, the court's decision shall not affect the validity of the ordinance as a whole, or any portion of the ordinance, except for the section of the ordinance that the court declares to be unconstitutional or invalid.

SECTION 4.0
ALLUVIAL FAN PLANNING AS PART OF GENERAL PLAN PROCESS

Section 65302(d)(3) of the California Government Code, which is part of the California Planning and Zoning Law, requires that the Conservation Element of the General Plan, upon the next revision of the Housing Element of the General Plan, identify rivers, creeks, streams, flood corridors, riparian habitats, and land that may accommodate floodwater for purposes of groundwater recharge and stormwater management. Section 65302(a) of the California Government Code requires that the Land Use Element of the General Plan give consideration to the identification of land and natural resources pursuant to Section 65302(d)(3), and also that the Land Use Element of the General Plan identify and annually review those areas covered by the Plan that are subject to flooding. Section 65302(g)(2) of the California Government Code further requires that the

Safety Element of the General Plan, upon the next revision of the Housing Element of the General Plan, (A) identify specified information regarding flood hazards; (B) establish a set of comprehensive goals, policies, and objectives based on that information for the protection of the community from the unreasonable risks of flooding; and (C) establish a set of feasible implementation measures designed to carry out these goals, policies and objectives. In addition to any requirements imposed by these state law provisions, [*name of city or county*], when updating its General Plan in accordance with these provisions, shall, at a minimum, identify the presence of any alluvial fans within the area covered by the General Plan and identify the potential flood hazards associated with any such alluvial fans. In so doing, [*name of city or county*] is authorized to rely upon the AFTF Integrated Approach and the AFTF Local Planning Tools.

SECTION 5.0
EVALUATING PROPOSED DEVELOPMENT ON AN ALLUVIAL FAN

5.1 DETERMINATION OF WHETHER THE PROPOSED DEVELOPMENT IS LOCATED ON AN ALLUVIAL FAN

(a) The requirements of this **Section 5.1** apply only to applications for development that require (independent of any provisions in this ordinance) a discretionary approval by [*name of city or county*].

(b) Whenever an application is submitted to [*name of city or county*] for any development covered by **Section 5.1(a)**, the application shall contain information sufficient to enable the Local Administrator to determine whether the proposed development is located, in whole or in part, on an alluvial fan.

(c) To satisfy the requirement in **Section 5.1(b)**, the applicant may: (1) rely on an evaluation that has been or is being conducted by [*name of city or county*] in accordance with **Section 4.0**; (2) rely on maps or other information available from local agencies or officials with responsibility for flood management and protection, the State of California, or Federal agencies such as FEMA; (3) utilize the AFTF Local Planning Tools and AFTF Integrated Approach; and/or (4) use an equivalent approach to the satisfaction of the Local Administrator.

> [**NOTE**: *Pursuant to the Permit Streamlining Act, and in particular Cal. Govt. Code § 65940, the local jurisdiction enacting this Model Ordinance will need to specify in advance the information pertaining to alluvial fans that will be required from any applicants for proposed development projects*.]

(d) To the extent [*name of city or county*] has previously conducted an evaluation in accordance with **Section 4.0** that resulted in a determination that the site of the proposed development is located on an alluvial fan, the applicant may present updated information and analysis to request a change in this determination.

(e) The Local Administrator shall, promptly after [*name of city or county*] has determined in accordance with its established procedures that the development application is complete, shall make a determination whether the proposed development is located, in whole or in part, on an alluvial fan. In making this determination, the Local Administrator shall consult with any local agencies or officials with responsibility for flood management and protection in [*name of city or county*].

(f) If the Local Administrator determines that the proposed development is located, in whole or in part, on an alluvial fan, then the Local Administrator shall comply with the provisions of **Section 5.2** of this ordinance.

(g) If the Local Administrator determines that no part of the proposed development is located on an alluvial fan, then nothing further is required under this ordinance.

(h) The information utilized by the Local Administrator for purposes of identifying whether an area is located on an alluvial fan will be on file at [*address: e.g., City Hall, County Administration Building, Department of Planning or Public Works, etc.*].

5.2 DETERMINATION OF WHETHER THERE IS AN ENGINEERED CONTROL STRUCTURE THAT WOULD ADEQUATELY PROTECT THE PROPOSED DEVELOPMENT FROM ALLUVIAL FAN FLOODING

(a) The requirements of this **Section 5.2** apply only where both of the following conditions exist: (1) the proposed development requires a discretionary approval by [*name of city or county*] as provided in **Section 5.1(a)**; and (2) the Local Administrator has determined that the proposed development is located, in whole or in part, on an alluvial fan.

(b) For a proposed development that meets the criteria specified in **Section 5.2(a)**, the Local Administrator shall consult with the local agencies or officials with responsibility for flood management and protection in [*name of city or county*] to ascertain whether they have determined that there are engineered control structures that are adequate to protect the proposed development from alluvial fan flooding.

(c) If the local agencies or officials with responsibility for flood management and protection in [*name of city or county*] have determined that there are engineered control structures that are adequate to protect the proposed development from alluvial fan flooding, then nothing further is required under this ordinance.

(d) If the local agencies or officials with responsibility for flood management and protection in [*name of city or county*] have not determined that there are engineered control structures that are adequate to protect the proposed development from alluvial fan flooding, then the Local Administrator shall comply with **Section 5.3** or **Section 5.4**, whichever one of these provisions is applicable according to its terms.

[NOTE: The following is an optional, additional provision that local communities may adopt for seeking credit points under FEMA's Community Rating System (CRS). Communities may adopt only one or two of the three requirements, but they will receive fewer points.]

(e) For a proposed development that meets the criteria specified in Section 5.2(a) where the local agencies or officials with responsibility for flood management and protection in [name of city or county] have not determined that there are engineered control structures that are adequate to protect the proposed development from alluvial fan flooding, the applicant for the proposed development must demonstrate to the Local Administrator that

1. All new structures are required to be protected from alluvial fan hazards;
2. All utilities are required to be designed to function and minimize damage during the 100-year event; and
3. Access to the development is required during the 100-year event.

5.3 CONSIDERATIONS FOR LARGER DEVELOPMENTS LOCATED ON AN ALLUVIAL FAN

(a) This **Section 5.3** applies only where all of the following conditions exist: (1) the proposed development requires a discretionary approval from [*name of city or county*] as provided in **Section 5.1(a)**; (2) the Local Administrator has determined that the proposed development is located, in whole or in part, on an alluvial fan; (3) the local agencies or officials with responsibility for flood management and protection in [*name of city or county*] have not determined that there are engineered control structures that are adequate to protect the proposed development from alluvial fan flooding; and (4) the proposed development is not a single-family residence, and either includes ten or more lots or is ten acres or larger.

(b) For a proposed development that meets the criteria specified in **Section 5.3(a)**, the Local Administrator shall, subject to the provisions of this **Section 5.3**, provide a written recommendation to the official or body of [*name of city or county*] that has discretionary decision-making authority over the proposed development. There is no prescribed format for the written recommendation, but the objective of the recommendation shall be to achieve the following three goals with respect to the proposed development: (i) to minimize the alluvial fan hazards; (ii) to minimize the costs that may result from these hazards; and (iii) to maximize the alluvial fan beneficial values.

(c) The official or body that has discretionary decision-making authority over the proposed development shall consider the written recommendation of the Local Administrator, but the written recommendation is not binding on the decision of that official or body with regard to the development. However, if the official or body with discretionary decision-making authority over the proposed development decides not to accept all or part of the Local Administrator's recommendation, then the official or body must provide a written explanation for that decision, which must be supported by evidence in the administrative record that accompanies the final decision with regard to the proposed development. This explanation shall be made available to the public as part of the decision-making process on the proposed development.

(d) Nothing in this ordinance shall be construed to extend or alter the deadlines for acting on a proposed development as set forth in the California Permit Streamlining Act, Cal. Gov. Code §§ 65920 et seq.

(e) When making the written recommendation referenced in **Section 5.3(b)**, the Local Administrator shall consult with any local agencies or officials with responsibility for flood management and protection in [*name of city or county*] and shall take into account the following considerations:

(1) The potential alluvial fan hazards that may be posed by locating the proposed development on the alluvial fan, including the hazards caused by modifying flood channels and by cumulative development on the alluvial fan.

(2) The flood protection facilities, procedures and protocols for the area of the proposed development.

(3) The funds available for flood protection projects or programs, including long-term maintenance and operations, in the area of the proposed development.

(4) The funds available for emergency response and preparedness, and for potential reconstruction, following damage caused by alluvial fan flooding or other alluvial fan hazards.

(5) The alluvial fan beneficial values (including the ecological, environmental, open space, flood protection, groundwater recharge and other benefits) that are provided where the development is proposed to be located on the alluvial fan area.

(6) Considerations for maximizing alluvial fan beneficial values and for minimizing alluvial fan hazards, including but not limited to whether there are any specific measures that could be implemented to minimize potential flood hazards that may result from locating the proposed development on an alluvial fan.

(f) In preparing the written recommendation as provided herein, the Local Administrator is authorized to rely upon the sources of information and the planning tools and approaches that are outlined in the AFTF Report, as specified in **Section 3.2**. The Local Administrator is also authorized to rely upon any additional relevant information pertaining to alluvial fans, including any information provided by the applicant for the proposed development.

(g) The written recommendation of the Local Administrator is not a final decision and may not be appealed administratively. However, a decision by [*name of city or county*] concerning the proposed development may be appealed in accordance with, and to the extent allowed by, the administrative appeal procedures of [*name of city or county*].

5.4 PROVISIONS FOR SMALLER DEVELOPMENTS

(a) This **Section 5.4** applies only where all of the following conditions exist: (1) the proposed development requires a discretionary approval from [*name of city or county*] as provided in **Section 5.1(a)**; (2) the Local Administrator has determined that the proposed development is located, in whole or in part, on an alluvial fan; (3) the local agencies or officials with responsibility for flood management and protection in [name of city or county] have not determined that there are engineered control structures that are adequate to protect the proposed development from alluvial fan flooding; and (4) the proposed development is either (i) a single family residence, or (ii) includes fewer than ten lots and is less than ten acres.

(b) For a proposed development that meets the criteria specified in **Section 5.4(a)**, the Local Administrator is not required to prepare a written recommendation. However, in making a final decision on the proposed development, [*name of city or county*] shall consider the factors listed in **Section 5.3(e)** to the extent feasible given the scale, nature and location of the proposed development.

APPENDIX E

TERMS
DEFINITIONS
AND
ACRONYMS

USEFUL TERMS-ACRONYMS-DEFINITIONS
Note: These are not necessarily legislative definitions of existing rules.

ACRONYMS

DWR California Department of Water Resources
FEMA Federal Emergency Management Agency
HEC-HMS Hydrologic Engineering Center-Hydrologic Modeling System
NFIP National Flood Insurance Program
NRC National Research Council
NRCS Natural Resources Conservation Service
USACOE U.S. Army Corps of Engineers
USGS U.S. Geological Survey

Alluvium: A general term for clay, silt, sand, gravel, or similar unconsolidated detritus material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semi sorted sediment in the bed of the stream or its floodplain or delta, or as a cone or fan at the base of a mountain slope; esp. such a deposit of fine-grained texture (silt or silty clay) deposited during time of flood.

Alluvial Fan Flooding: Flooding that occurs only on alluvial fans and is characterized by flow path uncertainty so great that this uncertainty cannot be set aside in realistic assessments of flood risk or in the reliable mitigation of the hazard. An active alluvial fan flooding hazard is indicated by three related criteria: (1) flow path uncertainty below the hydrographic apex; (2) abrupt deposition and ensuing erosion of sediment as a stream or debris flow loses its ability to carry material eroded from a steeper, upstream source area; and (3) an environment where the combination of sediment availability, slope, and topography creates an ultra hazardous condition for which elevation on fill will not reliably mitigate the risk (National Research Council 1996).

Inactive Alluvial Fan Flooding(b): Flooding that is similar to traditional riverine flood hazards, but occurs only on alluvial fans. Inactive alluvial fan flooding is characterized by flow paths with a higher degree of certainty in realistic assessments of flood risk or in the reliable mitigation of the hazard. Unlike active alluvial fan flooding hazards, an inactive alluvial fan flooding hazard is characterized by relatively stable flow paths. However, like areas of active alluvial fan flooding, inactive alluvial fan flooding, may be subject to sediment deposition and erosion, but to a degree that does not cause flow path instability and uncertainty (FEMA 2002).

Attribute: A characteristic of a geographic feature described by numbers, characters or images.

Avulsion: A sudden cutting off or separation of land by a flood or by an abrupt change in the course of a stream, as by a stream breaking through a meander or by a sudden changes in current, whereby the stream deserts its old channel for a new one. (From American Geological Institute Glossary of Geology).

Base flood elevation (BFE): The computed elevation to which floodwater is anticipated to rise during the base flood.

Base map: A rectified map containing geographic features such as roads for locational reference.

Braided channel: Interlacing or tangled network of several small branching and reuniting shallow channels separated from each other by branch islands or channel bars. Braided channels commonly appear to be part of a single channel and in plan appear to be strands of a complex braid. “Pockets” of braided channels should not be confused with the distributary channels of an inactive alluvial fan where the stable interfluves are above the channels.

Buffer Zone: An area of specified distance (radius) around a map item or items.

Channel (FEMA 2002) A naturally or artificially created open conduit that periodically or continuously contains moving water or which forms a connecting link between two bodies of water.

Clast: An individual constituent, grain, or fragment of a sediment or rock, produced by the mechanical weathering (disintegration) of a larger rock mass.

Debris flow: A mix of water and debris, which may include clasts ranging in size from clay particles to boulders and may contain abundant woody debris and other materials, that flows down a stream channel or steep slope, sometimes at great velocity, and contains more than 60 percent debris (less than 40 percent water) by volume.

Desert pavement: Surfaces of tightly packed gravel that armor, as well as rest on, a thin layer of silt, presumably formed by weathering of the gravel. They have not experienced fluvial sedimentation for a long time, as shown by the thick varnish coating the pebbles, the pronounced weathering beneath the silt layer, and the striking smoothness of the surface, caused by obliteration of the original relief by down wasting into depressions.

Desert varnish: A dark coating (from 2 to 500 microns thick) that forms on rocks at and near the Earth's surface as a result of mineral precipitation and eolian influx. The chemical composition of rock varnish typically is dominated by clay minerals and iron and/or manganese oxides and hydroxides, forming red and black varnishes, respectively. With time the thickness or the coating increases if abrasion and burial of the rock surface do not occur. As a result, clastic sediments on alluvial fan surfaces that have been abandoned for long periods of time have much darker and thicker coatings of varnish than do younger deposits.

Distributary flow: Diffuse flow where there is a distinct channel fork at an out flowing branch of a stream. Areas with distributary flow typically are composed of channel forks, joins and outlets. Active alluvial fans and granite pediments typically are characterized by distributary flow (Hjalmarson).

Eolian: Pertaining to the wind; esp. said of rocks, soils, and deposits (such as loess, dune sand, sand some volcanic tuffs) whose constituents were transported (blown) and laid down by atmospheric currents, or of landforms produced or eroded by the wind**,** or of sedimentary Structures (such as ripple marks) made by the wind, or of geologic processes (such as erosion and deposition) accomplished by the wind.

Flood: A general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters or (2) the unusual and rapid accumulation or runoff of surface waters from any source (FEMA 2002).

Flood Boundary and Floodway Map: (FBFM) The floodplain management map issued by FEMA that depicts, based on detailed flood hazard analyses, the boundaries of the 1 percent annual chance (100 year) and the 0.2 percent annual chance (500 year) floodplains and, when appropriate, the regulatory floodway. The FBFM does not show flood insurance risk zones or BFEs (FEMA 2002).

Flood flow Frequency Curve: A graph showing the number of times per year on the average those floods of certain magnitudes are equaled or exceeded (FEMA 2002).

Flood Hazard Mapping Program: The program undertaken by FEMA to conduct Flood Insurance Studies (FISs) and prepare reports and maps delineating flood hazards in flood prone communities throughout the United States (FEMA 2002).

Fluvial: Of or pertaining to or living in a stream or river; produced by river action, as in a fluvial plain.

GIS: Geographic Information System. An organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information. A geographic information system (GIS) is a computer-based tool for mapping and analyzing things that exist and events that happen on earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies.

Hydrograph: A graph showing stage, flow, velocity, or other properties of water with respect to time (FEMA 2002).

Hydrographic apex: The head or highest point on an active alluvial fan.

Hydrologic Analysis: An engineering analysis of a flooding source carried out to establish peak flood discharges and their frequencies of occurrence (FEMA 2002).

Hydrology: The science encompassing the behavior of water as it occurs in the atmosphere, on the surface of the ground, and underground (FEMA 2002).

Interfluve: The area between rivers; esp. the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction.

Lithology: The description of rocks, esp. sedimentary clastics and esp. in hand specimen and in outcrop, on the basis of such characteristics as color, structures, mineralogic composition, and grain size.

Morphology: The external structure form, and arrangement of rocks in relation to the development of landforms; the shape of the Earth's surface; geomorphology.

NFIP Flood Insurance Rate Zones

- **Zone A** is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the Flood Insurance Study by approximate methods of analysis. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.
- **Zone AE and A1-A30** are the flood insurance rate zones that correspond to the 1-percent annual chance floodplains that are determined in the Flood Insurance Study by detailed methods of analysis. In most instances, Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.
- **Zone AH** is the flood insurance rate zone that corresponds to the areas of 1-percent annual chance shallow flooding with a constant water-surface elevation (usually areas of ponding) where average depths are between 1 and 3 feet. The Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.
- **Zone AO** is the flood insurance rate zone that corresponds to the areas of 1-percent shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average flood depths derived from the detailed hydraulic analyses are shown within this zone. In addition, alluvial fan flood hazards are shown as Zone AO on the Flood Insurance Rate Map. Mandatory flood insurance purchase requirements apply.
- **Zone AR** is the flood insurance rate zone used to depict areas protected from flood hazards by flood control structures, such as a levee, that are being restored. FEMA will consider using the Zone AR designation for a

community if the flood protection system has been deemed restorable by a Federal agency in consultation with a local project sponsor; a minimum level of flood protection is still provided to the community by the system; and restoration of the flood protection system is scheduled to begin within a designated time period and in accordance with a progress plan negotiated between the community and FEMA. Mandatory purchase requirements for flood insurance will apply in Zone AR, but the rate will not exceed the rate for an unnumbered Zone A if the structure is built in compliance with Zone AR floodplain management regulations. For floodplain management in Zone AR areas, the property owner is not required to elevate an existing structure when making improvements to the structure. However, for new construction, the structure must be elevated (or floodproofed for non-residential structures) so that the lowest floor, including basement, is a minimum of 3 feet above the highest adjacent existing grade, if the depth of the Base Flood Elevation (BFE) does not exceed 5 feet at the proposed development site. For infill sites, rehabilitation of existing structures, or redevelopment of previously developed areas, there is a 3-foot elevation requirement regardless of the depth of the BFE at the project site. The Zone AR designation will be removed and the restored flood control system will be shown as providing protection from the 1-percent annual chance flood on the National Flood Insurance Program map upon completion of the restoration project and submittal of all the necessary data to FEMA.

- **Zone A99** is the flood insurance rate zone that corresponds to areas within the 1-percent annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No Base Flood Elevations or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.
- **Zone D** is used for areas where there are possible but undetermined flood hazards. In areas designated as Zone D, no analysis of flood hazards has been conducted. Mandatory flood insurance purchase requirements do not apply, but coverage is available. The flood insurance rates for properties in Zone D are commensurate with the uncertainty of the flood risk.
- **Zones B, C, and X** are the flood insurance rate zones that correspond to areas outside the 1-percent annual chance floodplain, areas of 1-percent annual chance sheet flow flooding where average depths are less than 1 foot, areas of 1-percent annual chance stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 1-percent annual chance flood by levees. No Base Flood Elevations or depths are shown within this zone. Insurance purchase is not required in these zones.

Piedmont: (adj.) Lying or formed at the base of a mountain or mountain range; e.g. a *Piedmont* terrace or a *piedmont* pediment. (n.) An area, plain, slope, glacier, or other feature at the base of a mountain; e.g. a foothill or a bajada.

Ponding: (FEMA 2002) The result of runoff or flows collecting in a depression that may have no outlet, subterranean outlets, rim outlets, or manmade outlets such as culverts or pumping stations.

Probability: The quantification of risk.

Regulatory Floodway: A floodplain management tool that is the regulatory area defined as the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the base flood discharge can be conveyed without increasing the BFEs more than a specified amount. The regulatory floodway is not an insurance rating factor (FEMA 2002).

Relict: A landform that has survived decay or disintegration (such as an *erosion remnant)* or that has been left behind after the disappearance of the greater part of its substance (such as a *remnant island).*

Resolution: The accuracy at which a given map scale can depict the location and shape of geographic features. The larger the map scale, the higher the possible resolution. As map scale decreases, resolution diminishes and feature boundaries must be smoothed, simplified, or not shown at all. For example, small areas may have to be represented as points.

Riverine: Pertaining to or formed by a river. Situated or living along the banks of a river; e.g. a "riverine ore deposit."

Riverine Flooding: The over bank flooding of rivers and streams (FEMA 2002).

Scour: (a) The powerful and concentrating clearing and digging action of flowing air or water, esp. the downward erosion by stream water in sweeping away mud and silt on the outside curve of a bend, or during time of flood. (b) A place in a stream bed swept (scoured) by running water, generally leaving a gravel bottom.

Sediment: Fragmental material that originates from the weathering of rocks and is transported by, suspended in, or deposited by water or air or is accumulated in beds by other natural occurrence (FEMA 2002).

Shallow Flooding: Unconfined flows over broad, relatively low relief areas, such as alluvial plains; intermittent flows in arid regions that have not developed a system of well defined channels; over bank flows that remain unconfined, such as on delta formations; overland flow in urban areas; and flows collecting in depressions to form ponding areas. For National Flood Insurance Program purposes, shallow flooding conditions are defined as flooding that is limited to 3.0 feet or less in depth where no defined channel exists (FEMA 2002).

Sheet flood: A broad expanse of moving, storm-borne water that spreads as a thin, continuous, relatively uniform film over a large area in an arid region and that is not concentrated into well defined channels; its distance of flow is short and its duration is measured in minutes or hours. Sheet floods usually occur before runoff is sufficient to promote channel flow, or after a period of sudden and heavy rainfall. According to Hogg (1982) a sheet flood is simply a sheet of unconfined floodwater moving down a slope. This definition implies a sheet flood is less frequent than a sheet flow. The Committee on alluvial fan flooding of the National Research Council (1996) was more specific when they defined sheet flood as "a broad expanse of moving, stormborne water that spreads as a thin, continuous, relatively uniform film over a large area in an arid region and that is not concentrated into well defined channels; its distance of flow is short and its duration is measured in minutes or hours. Sheet floods usually occur before runoff is sufficient to promote channel flow, or after a period of sudden and heavy rainfall."

Sheet Flow: An overland flow or down slope movement of water taking the form of a thin, continuous film over relatively smooth soil or rock surfaces and not concentrated into channels larger than rills. This flow typically is short lived with a limited travel distance. Most surface runoff starts as overland flow and commonly enters rills before it concentrates in channels. Natural overland flow is characterized by several lateral down slope concentrations of flow rather than uniform sheet flow (Emmett, 1970). See *Sheet Runoff*.

Sheet Runoff: The broad, relatively unconfined down slope movement of water across sloping terrain that results from many sources, including intense rainfall and/or snowmelt, overflow from a channel that crosses a drainage divide, and overflow from a perched channel onto deltas or plains of lower elevation. Sheet runoff is typical in areas of low topographic relief and poorly established drainage systems (FEMA 2002).

Slope: A measure of change in surface value over distance, expressed in degrees or as a percentage. For example, a rise of 2 meters over a distance of 100 meters describes a 2% slope with an angle of 1.15. Mathematically, slope is referred to as the first derivative of the surface.
Special Flood Hazard Area (SFHA): The area delineated on a National Flood Insurance Program map as being subject to inundation by the base flood. SFHAs are determined using statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with a community; floodplain topographic surveys; and hydrologic and hydraulic analyses (FEMA 2002).

Stable: The relative state of the location, geometry and roughness of a channel, network of channels or landform where any changes of location, geometry and roughness can be set aside in realistic assessments of flood risk.

Stable Channel Flooding: A deeply entrenched channel or network of channels often is subject to inactive alluvial fan flooding. This type of flooding usually occurs within distributary flow systems that were formed during climatic or tectonic conditions different from the present. This flooding can occur at the head of the alluvial fan but become unstable downstream. Conversely, unstable channels can become stable in the downstream direction; this can occur because of headcutting into the toe as a result of changing hydraulic conditions downstream from the toe. Human intervention, directly by channel modification or indirectly by land use change, can create stable channels.

Stratigraphy: (a) The branch of geology that deals with the definition and description of major and minor natural divisions of rocks (mainly sedimentary, but not excluding igneous and metamorphic) available for study in outcrop or from subsurface, and with the interpretation of their significance in geologic history: It involves interpretation of features of rock strata in terms of their origin, occurrence, environment, thickness, lithology, composition, fossil content, age, history, paleogeographic conditions, relation to organic evolution, and relation to other geologic concepts. (b) The arrangement of strata, esp. as to geographic position and chronological order of sequence.

Swale: (a) A slight depression, sometimes swampy, in the midst of generally level land. (b) A shallow depression in an undulating ground moraine due to uneven glacial deposition. (c) A long, narrow, generally shallow, trough-like depression between two beach ridges, and aligned roughly parallel to the coastline.

Throughflow streams: Are streams that head in the mountains and cross piedmonts to base level streams or to depositional landforms on lower piedmont slopes (H. W. Hjalmarson).
Topographic apex: The highest point on an alluvial fan where flow is last confined.

Uncertain distribution of flow: Means that the distribution of flow at channel splits (forks) is not precisely known because the channel geometry may change with time and because of hydraulic model limitations such as common assumptions of steady flow or a horizontal water level above the split (H. W. Hjalmarson).

Uncertain flow path: Means that the perceived, historical channel or network of channels cannot be relied on to convey the base flood without the creation of new flow paths or the abandonment of existing flow paths.

Unstable: The relative state of the location, geometry and roughness of a channel, network of channels or landform where any changes of location, geometry and roughness cannot be set aside in realistic assessments of flood risk.

Wash: (a) A term applied in the western U.S. (esp. in the and semiarid regions of the south west) to the broad, shallow, gravelly or stony, normally dry bed of an intermittent or ephemeral stream, often situated at the bottom of a canyon; it is occasionally filled by a torrent of water. (b) Loose or eroded surface material (such as gravel, sand, silt) collected, transported, and deposited by running water, as on the lower slopes of a mountain range, esp. coarse alluvium.

Watershed: An area of land that drains into a single outlet and is separated from other drainage basins by a divide (FEMA 2002).

Water Surface Elevations (WSELs)**:** The computed heights of floods of various magnitudes and frequencies in the floodplains of coastal or riverine areas, in relation to a specified vertical datum (FEMA 2002).