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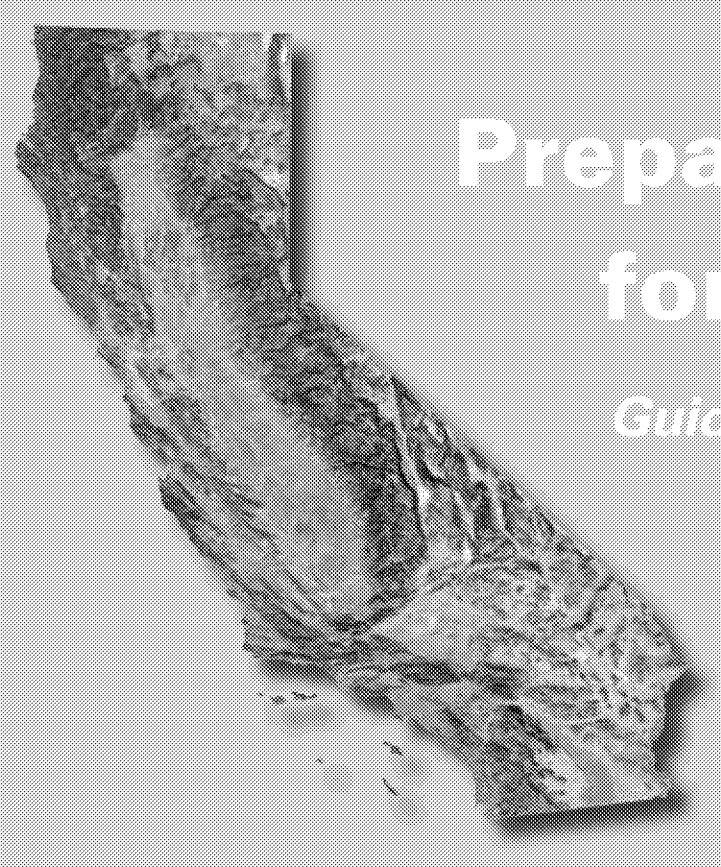

Preparing California for Extreme Heat:

Guidance and Recommendations

Matthew Rodriquez
Secretary for
Environmental Protection

Edmund G. Brown Jr.
Governor

Ron Chapman, MD, MPH
California Department of Public Health

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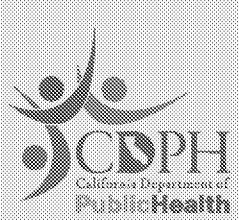
Developed by the Heat Adaptation Workgroup,
a subcommittee of the Public Health Workgroup,
California Climate Action Team (CAT)

Cal/EPA
California Environmental Protection Agency



October 2013

Table of Contents

Purpose and Intended Use of This Document

The Climate Action Team's[1] Public Health Workgroup convened a subcommittee, the Heat Adaptation Workgroup, to develop this document. The Heat Adaption Workgroup was co-chaired by the California Department of Public Health (CDPH) and the California Environmental Protection Agency (Cal/EPA) and includes staff from multiple State agencies. (See the Acknowledgements for the full list of participating agencies and departments, page 21).

As the climate changes in California, extreme heat is projected to be a growing problem that will have health, economic, ecological, and social impacts. Actions taken by government agencies and other entities in the coming years could mitigate the effects of extreme heat and reduce resulting disabilities and deaths. This document provides guidance for incorporating extreme heat projections, based on current climate change models, into planning and decision making in California.

This guidance provides an overview of current climate projections for increased temperature and extreme heat conditions for California, describes the health effects of extreme heat, and presents recommendations for state and local planners, local governments, emergency response, and public health and health care professionals and institutions. The early integration of extreme heat projections into plans, policies and projects will lessen the potential impacts of the state's warming climate, as will modifications made to cool the built environment of urbanized areas where over 95% of California's population lives.

The guidance does not attempt to look at the many indirect effects of increased temperature, such as wildfire, drought, and changes in agricultural production, that are expected to pose additional challenges to human health and well-being in California. Although increased temperatures related to climate change will affect the built environment and service delivery systems, these issues are not directly addressed here.

Several state resources provide a more comprehensive overview of climate change impacts and adaptation information and planning guidance, including the impacts of heat beyond the health effects addressed in this Guidance.

- 2013 Update to the California Adaptation Strategy (2013)
- California Adaptation Planning Guide (2012)

See the Resources section on page 19 of this Guidance.

1 The Climate Action Team (CAT) members work to coordinate statewide efforts to implement global warming *emission reduction programs* and the state's *Climate Adaptation Strategy*. The *CAT members* are state agency secretaries and the heads of agency, boards and departments, led by the Secretary of Cal/EPA. The CAT oversees nine Working Groups, one of which is the Public Health Workgroup. Its task is to address cross-cutting issues related to climate change and health. The Public Health Workgroup is responsible for providing public health input into the AB 32 implementation process, as well as other public health issues related to climate change mitigation and adaptation.

Climate Change and Extreme Heat Projections for California

Heat ranks as among the deadliest of all natural hazards (Borden et al, 2008). Even though heat-related deaths and illnesses are largely preventable, many people annually succumb to extreme heat. In a 10-day California heat wave in 2006, over 650 people died due to heat-related conditions. In 2003, during an extended heat wave impacting much of Europe, over 70,000 died. Other U.S. and European heat waves with significant mortality are shown in Table 1.

Table 1. Recent US and European Heat Waves

Extreme Heat Incident	Deaths
Philadelphia heat wave, 1993	118
Chicago heat wave, 1995	739
European heat wave, 2003	70,000
California heat wave, 2006	650
Russian heat wave, 2010	11,000-50,000

Characteristics of Extreme Heat Events

The National Weather Service (NWS) issues an Excessive Heat Warning/Advisory when an extreme heat event (a "heat wave") is expected within the next 36 hours. Typically, the NWS issues these warnings based on a "Heat Index" - a combination of heat and humidity - that is predicted to be 105 °F or greater for two or more consecutive days, although the temperature cut-off varies for different regions. In California, local weather forecast offices may use different criteria for Excessive Heat Warning/Advisories based on maximum temperatures, nighttime temperatures, and other methods. Although the NWS generally uses a certain Heat Index cut-off for their Excessive Heat Warnings, many experts recommend using relative - rather than absolute - temperature to define extreme heat events. For example, the Centers for Disease Control and Prevention define extreme heat as "summertime temperatures that are substantially hotter and/or more humid than average for that location at that time of year". Under this approach, which is used by most health organizations, a mid-summer extreme heat event in San Francisco may have a similar Heat Index as an average autumn day in Fresno. People living in areas that are generally cool are at risk of heat-related illness at cooler temperatures than people who have become more acclimatized to heat and who also have more access to air conditioning. Acclimatization is a process whereby the healthy body gradually adapts to heat by various physiologic mechanisms over a period of several weeks of recurrent exposure to heat.

To make projections of expected impacts of heat events on human health, one must first have an estimate of how heat events will change in the future due to effects of climate change. Several characteristics of heat events are of public health concern: (1) how extreme the events will become, (2) how frequently they will occur, (3) whether or not the duration of the events will change; (4) whether or not the seasonality of the events will change (i.e., whether heat events are expected to occur earlier or later in the annual cycle), and (5) whether the geographical extent of the events will change.

Heat Event Projections for California in a Changing Climate

In order to project how heat events will change in the future, climatologists first examine several global climate models, based on different assumptions, rather than one model, to obtain a more complete picture based on a range of projections. These models exhibit variability due to differences in representing how greenhouse gas (GHG) emissions will affect the climate

Secondly, climatologists look to different emission scenarios to estimate how GHG emissions may change in the future. Different emission scenarios lead to different levels of heating. Finally, the temperature projections are downscaled from a coarse level to a finer spatial scale in order to be useful at a regional or local level.

For California, most projections of heat events have been conducted with cooperation from the Scripps Institute of Oceanography, University of California, San Diego. Table 2 summarizes the research on projecting temperature increases in California. The models have been consistent in projecting increases in annual average temperature of up to 5° F by the 2030s and up to 10° F by the end of the century or sooner, although not every day will be hotter. This work has also indicated that extreme temperature events will occur more frequently. Minimum nighttime temperatures are also predicted to increase and should be considered. For example, the 2006 CA heat wave was hot and humid particularly at night.

Table 2. Summary of Temperature Projections for California

Model	Findings
Hayhoe, et al.2004	Increase of 3°-5° F in state-wide average temperature by 2030s and up to 9° F for summer average by 2050s under high emission scenario
Drechsler, et al.2006	Summer daily maximum temperatures would increase by 2.2°–7.6° F by 2035–2065
Cayan, et al.2009	Increase in state-wide annual average temperature between 2.8°-10.8° F by end of century
Mastrandea, et al.2009	Extreme temperatures currently estimated to occur once every 100 years would occur annually under high emission scenario
Ostro, et al.2011	Statewide changes in annual average temperature of 1.9° F in 2025 and 4.6° F in 2050 would translate to 2,100 to 4,300 excess deaths in 2025 and 6,700 to 11,300 excess deaths in 2050.

Cal-Adapt (*http://cal-adapt.org/*) is an online resource funded by the California Energy Commission to display climate change data at a local level. Cal-Adapt currently uses Scripps' model data to display local level projections for increases in temperatures. For example, Cal-Adapt shows average maximum temperature projections by month and day for a specific location. It also shows projections of increases in extreme heat days and heat waves, which is of great importance for public health planning.

Cal-Adapt defines extreme heat days as above the 98th percentile of the computed maximum temperature for each location using 1961-1990 data for the May to October warm season. These data are useful for targeting heat illness prevention and for estimating health impacts from increasing heat events.

Cal-Adapt projects that urban and rural population centers throughout California will experience an average of 40 to 53 extreme heat days by 2050 and an average of 40 to 99 days by 2099. This compares to a historical average of 4 per year. Table 3 shows several examples.

Table 3. Model Estimated Extreme Heat Days May 1 to Oct 1 in Selected California Cities*,2050 and 2099

City	2050	2099
Bakersfield	48	93
El Centro	60	101
Fresno	46	90
Los Angeles	78	110
Redding	35	75
Sacramento	44	85
San Diego	76	129
San Francisco	39	126
San Jose	71	111
Truckee	41	83

* High emission scenario A2 using average of four models
Number of days exceeding 98th percentile of baseline temperatures, based on a 1961-1990 baseline of four extreme heat days per year.
Source: Analysis based on Cal-Adapt

Populations in cooler areas in California may be at greater risk of heat-related illness because (a) individuals are less acclimatized to heat, (b) people are less aware of the behaviors that can reduce exposure (e.g., reduce activity level or go to an air conditioned location) or reduce physiologic stress (e.g., appropriate hydration), and (c) the built environment is not designed for warmer conditions (e.g., homes, workplaces and institutions are less often equipped with air conditioning or it is inadequate for extreme or prolonged heat events). In addition, communities in these locations, inadequately aware of the risk, may not have plans or capacity for emergency mitigation measures.

During the 2006 California heat wave, a greater increase in emergency room (ER) visits and hospitalizations for heat-related illnesses occurred in the normally cooler coastal counties (Knowlton et al., 2009; Gershunov et al., 2011). Apparent temperature, a combination of both temperature and humidity, was associated with ER visits during the warm season in California in a recent study (Basu et al., 2012). In addition, relative humidity was associated with ER visits for mental health complaints (Gershunov et al., 2011). While people may be able to acclimatize to warmer summers in general, rare extremes may be beyond their capacity. Additional risks can occur due to micro-environments in homes due to humidity and heat exposures (Basu and Samet, 2002). Individual monitoring of these environments may be important to better understand and reduce these risks.

Urban Heat Islands and the Built Environment

Temperatures in most urban areas are significantly higher than in surrounding, less urbanized areas because pavement and building materials absorb sunlight and heat. This phenomenon is known as the urban heat island effect (Imhoff et al., 2010). Daytime temperatures in urban areas are on average 1-6° F higher than in rural areas, while nighttime temperatures can be as much as 22° F higher as the heat is gradually released from buildings and pavement (U.S. EPA, 2008). Pavements cover a third of a typical U.S. city (Akbari et al., 2009), mostly with asphalt, which reflects only 10 percent of the sunlight shining upon it. Building density, design and materials, heat from industrial operations, machinery, air conditioners and vehicles, road pavement, and lack of vegetation all contribute to the creation of heat islands.

The concentration of heat in urban areas creates health risks both because of heat exposure and the enhanced formation of air pollutants, especially ozone. The strong influence of the urban heat island on nighttime temperatures limits the ability of people to cool down and recover before the heat of the next day, and therefore adds to the risk of illness and fatalities.

The most intense urban heat island effects are often seen in neighborhoods where dense land use and impervious, paved surfaces predominate and trees, vegetation and parks are less common. Access to the cooling effects of urban greening and open space is often most limited for low-income urban communities. Strategies that can reduce the urban heat island effect include increasing urban greening (such as trees, parks, gardens and green roofs), and using lighter-colored or cooler materials (such as porous pavements and cool roofs[2]). Building insulation may also help by protecting the occupants from temperature extremes. These strategies, identified below in bold type, can make a significant difference in temperatures and health risks in urban areas.

Shading of buildings, asphalt and other dark surfaces with trees can reduce the urban heat island effect. Tree planting requires adequate space, water, and maintenance, and the correct selection of trees. Direct shading of buildings also reduces heat in buildings in the event of power outages in an extreme heat event. Solar panels placed on canopies over parking lots and other paved surfaces can also shade and reduce the urban heat island effect. The Legislature has mandated the promotion of solar power, even if it requires reducing the amount of tree canopy coverage.[3]

California's Building Standards contain both mandatory and voluntary **green building standards**. The more aggressive voluntary standards are often adopted by local governments that have made a commitment to higher levels of energy efficiency and sustainable built environments beyond what is required in the statewide building code. These voluntary standards can be an important roadmap to document the "next steps" that should be taken in future mandatory building codes. The Green Building Standards Code[4] does not have a formal process to move the voluntary measures into the mandatory requirements. While cost-effectiveness has been identified as one important factor in making this decision, health effects have not previously been a primary consideration. Non-vegetative landscape elements (hardscape alternatives such as pervious paving materials) that reduce the heat island effect are a good example of a voluntary measure that could become mandatory in future updates to the Green Building Standards Code.

Cool roofing contributes to reduced energy consumption and an associated reduction in GHG emissions. Cool roofing also contributes to mitigating the urban heat island effect, which is important to protecting human health. Recent studies suggest that significant climate cooling could be achieved with increased application of cool roofing in urban areas (Surabi, 2010). The most cost effective way to mitigate the urban heat island is to accelerate the adoption of reflective roofs. Dark roofs can reach temperatures over 66° C (150° F) on summer days. A white or cool roof under the same conditions would stay at least 28° C (50° F) cooler than dark roofs.

Some **energy efficiency measures** in houses and small commercial buildings can help to keep the indoor environment within comfortable temperature conditions without use of air conditioning during extreme heat events. These measures (e.g. roof deck insulation, wall insulation, high performance windows, and building orientation) are also important to include in building designs because they are "passive" – they work without reliance on electrical power.

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2 A cool roof is one that reflects the sun's heat and emits absorbed radiation back into the atmosphere. The roof literally stays cooler and reduces the amount of heat transferred to the building below, keeping the building a cooler and more constant temperature. A cool roof need not be white. Many "cool color" products use darker-colored pigments that are highly reflective in the near infrared (non-visible) portion of the solar spectrum. (*www.coolroofs.org*)

3 Solar panels are promoted through the Solar Shade Control Act (*Pub Res Code*), the Solar Rights Act (*Govt. Code 65850.5*), the California Solar Initiative (*Pub Res Code §25405.5(b)*) and through a CEQA exemption for onsite solar (*Pub Res Code*).

4 The Green Building Standards Code (*CALGreen* Code) is Part 11 of California's building codes (California Code of Regulations, Title 24).

The **management and restoration of parks and riparian zones in urban areas** increases vegetated areas, which can help reduce heat island effects. Increasing recreational and riparian spaces in urbanized areas has many co-benefits including health benefits from air and water quality improvements. Ideally these measures should be coordinated under a watershed management plan or parks master plan.

Assembly Bill 296 (Skinner, Chapter 667, Statutes of 2012) advises the State to develop a standard specification for sustainable or **cool pavements**. These are pavements that include a range of established and emerging technologies that communities are exploring as part of their heat island reduction efforts. The term currently refers to paving materials that reflect more solar energy, enhance water evaporation, are more porous, or have been otherwise modified to remain cooler than conventional pavements.

Health Effects from Heat

Heat-related illness includes a spectrum of illnesses ranging from heat cramps to severe heat exhaustion and life-threatening heat stroke. Heat-related illness results from the "body's inability to dissipate heat produced by metabolic activity, often as a result of increased ambient temperature" (Wexler, 2002).

Heat-Related Illnesses

Heat cramps involve severe painful cramping of the muscles in the arms, legs or abdomen often accompanied by swelling of the legs and feet. It is not immediately dangerous, but is a signal of significant stress on the body from heat. If heat cramps are not treated with cooling and hydration, the person is at risk of developing heat exhaustion and heat stroke.

Heat exhaustion is more serious and generally includes an elevated core body temperature that is up to 104° F. Symptoms of heat exhaustion include generalized malaise, weakness, nausea, vomiting, headache, irritability, confusion, rapid heart rate and sweating (often with cold, clammy skin). Active cooling of the affected individual is needed. Untreated heat exhaustion can progress to heat stroke within minutes or hours.

The most serious illness is **heat stroke**, a severe and life-threatening failure of the body's ability to cool (e.g., sweating ceases), with core temperature generally over 104° F. Heat stroke includes severe mental status changes, seizures, loss of consciousness, kidney failure and abnormal cardiac rhythm. This catastrophic illness can be distinguished from heat exhaustion by two factors: changes in mental status (ranging from delirium to coma) and hot, dry skin. Elevated temperature over a specific cutoff is not necessary for the diagnosis of heat stroke. Heat stroke is an extreme medical emergency that if not promptly treated frequently results in death or permanent neurological impairment. With prompt and appropriate emergency medical treatment, survival can approach 100%.

A study of the California heat wave of July 2006 (Ostro et al., 2009) reported that the number of deaths following a heat wave was severely underestimated by coroners› reports (which reported 140 deaths), and that the actual number of deaths was three to five times higher than deaths that would be expected during other time periods (Basu et al., 2008; Basu and Ostro, 2008; Basu et al., 2011). A follow-up study by the California Department of Public Health estimated that 655 excess deaths occurred during the 2006 heat wave (Hoshiko et al., 2010).

Because no standardized definition for heat-related death currently exists in the US, heat-related deaths are severely under-reported. They may only be reported during a heat wave although they also occur on hot days that are not defined as heat waves (Basu and Samet, 2002; Basu, 2009). California has no statewide, real-time surveillance system or central medical examiner for heat illness and/or death. Current death data resides in coroners' and medical examiners' files and death certificates in each of the 58 counties, and also in death certificates. As a result, the State has no way to rapidly identify and respond effectively to heat illnesses that may occur during extreme heat events or ascertain the extent of heat wave impacts on health.

Employers are required to report work-related deaths and/or serious illness, including those due to heat, to their local Cal/OSHA district office. These reports trigger an enforcement investigation and have been used in the past for statewide surveillance activities. However, insufficient

resources are available to maintain ongoing surveillance and epidemiologic surveillance using these data. Workers' compensation records have also been used to conduct retrospective analysis of heat illness cases in the workplace.

Populations at Risk from Heat

Heat-related illness can be classified as "exertional" or "classic," and different populations are at risk for each type.

The majority of non-working victims during heat waves suffer from "classic" heat-related illness. Several studies have found that these are acute illnesses and deaths with the greatest risk on the same day as exposure. The following groups are mainly at risk of "classic" heat related illness: young children, the elderly, persons with pre-existing chronic diseases (e.g. respiratory, cardiovascular, diabetes) (Green, 2010), pregnant women (Basu et al., 2010), those who are socially isolated and those who have a disability. The elderly are at higher risk due to reduced ability to acclimatize to changing temperatures, for example reduced sweating, diminished thirst response even when dehydrated and higher likelihood of pre-existing chronic health conditions. Heat-related deaths have been shown to be greater for those with cardiovascular diseases, as well as for African-Americans, infants, children and the elderly (Basu and Ostro, 2008).

"Exertional" heat-related illness generally affects persons engaged in vigorous physical activity, which causes the body to generate internal heat, and occurs during hot and/or humid environmental conditions that reduce the body's ability to dissipate heat. This type of heat illness affects workers (outdoor and indoor), outdoor athletes (especially young athletes) and military personnel.

For workers, exertional heat illness occurs across a wide age range and in numerous industries and occupations, including: agriculture, construction, firefighting, warehousing, delivery, and service work. Although a significant number of California workers have experienced severe heat-related illness and death during heat waves in recent years, exertional work-related heat-illness is believed to be under-reported and not well captured by existing data systems.[5] Since 2005, California employers have been required to provide basic elements to protect outdoor workers—adequate water, shade, rest breaks, training and emergency procedures.[6] Such provisions can mean the difference between life and death. In 2010, the standard was strengthened to include a high heat provision that must be implemented by five industries (agriculture, construction, landscaping, oil and gas extraction and transportation or delivery of agricultural products, construction material or other heavy materials) when temperatures reach 95° F. These enhancements included mandates to remind employees to drink water more frequently, to observe employees for signs and symptoms of heat illness, to ensure effective communications to summon help if needed, and to provide close supervision of new employees.

Heat emergencies impact service provision by government, business, and community organizations. Information on vulnerable populations they serve may improve the prioritization, timing, geographic coverage, communication, coordination, and evaluation of these services.

Air Conditioning: A Dilemma

During extreme heat events when power shortages are more likely to occur, utilities request that consumers and businesses decrease their use of electricity to reduce demand on the energy grid, especially during peak load hours. In some cases, excessive energy demand may result in rolling blackouts affecting part or all of service areas.

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5 Cal Code of Regs, Title 8, §342. Reporting Work-Connected Injuries, (*http://www.dir.ca.gov/title8/342.html*).

6 Cal Code of Regs, Title 8, §3395. Heat Illness Prevention, (*http://www.dir.ca.gov/title8/3395.html*).

During extreme heat events public health officials recommend that members of vulnerable groups stay inside or move to cooler locations, such as an air conditioned dwelling (the most common and convenient place) or a mall, library, community center or designated "cooling center." Heat warnings and public service announcements identify key actions such as staying hydrated, wearing light clothing, checking on elderly neighbors/relatives and other behavioral changes to reduce risks of heat illness. Several studies have shown an unequal access to air conditioning across California based on income and race in areas subject to extreme heat. Some renters may not have access to air conditioning or may face obstacles to installing and paying for their own units. Coastal areas, cooled by ocean influences and fog, have not "needed" air conditioning as much as inland areas.

The cost of air conditioning can be a barrier to low income and vulnerable populations even when it is available and recommended. Not all members of vulnerable groups currently know about or access utility or government energy subsidy programs (Low Income Home Energy Assistance Program[7]). These programs may not have enough resources to assist all who need coverage.

Air conditioning provides relief from the heat for the occupants of the building where it is running, but fossil-fuel based energy use generates additional greenhouse gases emissions. Cool roofs can help with this dilemma, particularly in buildings with little insulation. Cool roofs can lower indoor temperatures and may help residents remain comfortable with less air conditioning during the hottest periods of the day. Another problem can arise when, during extreme heat events, a Flex Alert[8] requests the public to set their thermostats at 78° F or higher during the peak period -- at the same time that public health officials encourage vulnerable populations to use and seek the protection of air conditioning.

As the climate in California changes, prolonged heat events are likely to impact areas currently unaccustomed to heat waves such as communities in California's coastal region, more northern latitudes and higher elevations. Houses, schools and workplaces in these communities, as well as older buildings throughout the State (e.g., in older urban neighborhoods and in rural areas), generally do not have insulation or air conditioners or have air conditioning units that do not provide adequate cooling under extreme heat conditions. Some vulnerable subpopulations, such as the poor or elderly, may not have access to air conditioning, or they may choose to not use it to avoid expenses to limited, fixed incomes. In addition, the very young and the elderly, as well as people with various illnesses, are less able to become acclimatized to heat over time, so they remain at risk of heat illness when healthy people may successfully adapt to higher temperatures.

Air Quality and Heat Exposure

Degradation of air quality will compound the health hazards posed by increases in temperature. Higher temperatures favor the formation of ground-level ozone and other secondary air pollutants created from chemical reactions with pollutants directly emitted from power plants, motor vehicles, and other sources. Poor air quality can adversely affect the health of many Californians, with a disproportionate disease burden among the elderly, children, and those with chronic underlying disease. Air Pollution Control Districts throughout the State are recognizing the link between air quality and extreme heat events related to climate change and are beginning to develop programs to respond to the issue. With the projected increased occurrence of extreme heat events, demand for electric power generation will increase. This may contribute to further degradation of air quality despite efforts to control power plant emissions.

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7 Low Income Home Energy Assistance Program (LIHEAP) is a Federally-funded program that helps low-income households with their home energy bills. The California Department of Community Services & Development administers *the program* at the State level.

8 Funded by the investor-owned utilities and authorized by the CA Public Utilities Commission, Flex Alerts are part of an educational and emergency alert program that informs consumers about how and when to conserve electricity. The California Independent System Operator issues a *Flex Alert* during heat waves and other challenging grid conditions such as wildfires or when major power plants or power lines are unavailable.

Recommendations

California faces temperature increases throughout the state over the next 80 years that will pose considerable health risks to our population, especially to a number of vulnerable groups. Preparing for these changing conditions will require a combination of strengthening our preparedness for extreme heat events and adaptation by modifying and cooling the built environments in which we live.

The Heat Adaptation Workgroup developed the following recommendations to guide the state's efforts to become more prepared and resilient to increasing temperature and extreme heat events. The recommendations below are primarily aimed at state government agencies, but they have application at the local and regional level as well, particularly through partnerships with responsible agencies listed in the following sections.

State agencies or departments identified as a "lead agency" should review specific recommendations with other agencies and stakeholders, and discuss implementation strategies, priorities and necessary resources. The Workgroup acknowledges that some recommendations may be readily implemented while others will require additional planning, consultation and resources. In the course of considering these recommendations, lead agencies should discuss and consider whether a particular recommendation can be advanced and/or implemented using existing resources or whether there are additional costs associated with implementation.

Many existing state and local plans, policies and programs are already in place to address heat, but they have not yet incorporated up-to-date climate change information. The recommendations presented here will help the public and all levels of government to be prepared, coordinated, and have the resources to respond to hotter, longer and more frequent extreme heat events.

These recommendations also present several priority research/evaluation needs and actions. Partnerships and multi-disciplinary efforts between state and local government, the public health and health sectors, social service agencies, business, labor, utilities and representatives of the most vulnerable populations are highlighted in specific areas.

Section I: Heat Resilient and Cooler Communities

1. **Review and incorporate changes as appropriate, to state and local regulations, codes and industry practices for buildings, land use and design elements to identify opportunities to accelerate the adoption of cooling strategies for both indoor and outdoor environments.**
   Lead Agency: *Building Standards Commission (i., ii. below), California Energy Commission (iii. below), Governor's Office of Planning and Research (iv. below).*
   Other Agencies and Stakeholders: *Air Resources Board, local and regional planning agencies.*

   i. **Update Title 24, Part 11: California's Green Building Standards in CA Building Code.** Update Title 24, Part 11 to include measures that should be required in the future to mitigate the health risks of extreme heat events in the built environment. Incorporate consideration of health impacts as part of that process.

   ii. **Update Title 24, Part 6: Building Energy Efficiency Standards.** Consider measures which both cool internal building space and contribute to larger environmental cooling to reduce the build-up of heat via urban heat island mechanisms.

   iii. **Incorporate indoor air quality.** Incorporate best practices into revision of residential and commercial building standards and codes to ensure thermal comfort and healthful indoor air quality.

   iv. **Incorporate cooling strategies in land use.** Work with local governments to consider cool land use elements as part of sustainable community planning and implementation, especially for areas where dense building (infill, transit oriented development, transit corridors, etc.) patterns might contribute to more urban heating.

2. **Develop an urban heat island effect index.**
   Lead Agency: *California Environmental Protection Agency.*
   Other Agencies and Stakeholders: *Air Resources Board, Governor's Office of Planning and Research, Building Standards Commission, Caltrans, Department of General Services, California Energy Commission, local governments, local and regional transportation departments, local and regional planning agencies.*

   Develop a definition for the urban heat island effect consistent with the Legislative intent in Assembly Bill 296 (Skinner, Chapter 667, Statutes of 2012). As part of this work, provide an urban heat island effect index for California cities that would allow the cities to set quantifiable goals for heat reduction, including means to measure heat and GHG reduction benefits of various cool or sustainable materials strategies.

3. **Examine and expand the use of cool, porous, or sustainable materials in pavements.**
   Lead Agency: *Caltrans, Governor's Office of Planning and Research, Department of General Services.*
   Other Agencies and Stakeholders: *California Environmental Protection Agency, local governments, local and regional transportation departments.*

i. Develop standard specifications for cool, porous or sustainable pavements that can be used to reduce urban heat island effects. On state-managed surfaces, expand the use of cool or porous pavements and sustainable materials to lower night time surface temperatures and reduce storm water run-off as compared to other pavements. Responsibility for many paved surfaces such as state-owned parking facilities, park and ride lots, state highways and maintenance station parking areas, lies with the Departments of General Services (DGS) and Transportation (Caltrans). By adopting specifications for the use of these cool, porous or sustainable pavements and implementing them on state-managed surfaces, DGS and Caltrans can provide a template for implementation by local governments, regional transportation agencies, and the private sector.

ii. Consider updating the California Green Building Standards Code during its next triennial update to include any standard specifications for cool or sustainable pavements developed by Caltrans or DGS, as well as any other appropriate updates for urban greening, hardscape standards, or cool roofs.

4. **Promote and expand urban greening and the use of green infrastructure as part of cooling strategies in public and private spaces.**
Lead Agency: *CAL FIRE, Governor's Office of Planning and Research, California Department of Public Health.*
Other Agencies and Stakeholders: *Natural Resources Agency, Caltrans, California Energy Commission, Department of Fish and Wildlife, Department of Conservation, State Water Resources Control Board, Strategic Growth Council, local governments, local parks departments and districts, local health departments, urban greening/urban forestry non-governmental organizations.*

i. **Plant trees.** Increase tree canopy cover percentage, especially for high-risk areas like the Inland Empire and San Joaquin Valley, and especially for areas with highest urban heat island contribution: large parking lots, arterial roads, dark roofs on buildings. Avoid trees that produce abundance of allergens or Volatile Organic Compounds or require excessive water. Avoid conflicts with photovoltaic systems when siting trees.

ii. **Use vegetation.** Use alternative vegetative solutions to alleviate urban heat island: for example, green walls and green roofs where trees are not possible. These solutions are more costly than trees, but still provide significant benefit.

iii. **Shade green open space.** Use trees to provide shade at places where people recreate. This could be a cost effective solution for parking lots, parks, walking and bike paths, and tracks.

iv. **Restore urban streams.** Where possible, restore natural geomorphic and hydrologic features to failing culverted and channelized streams in urban areas.

v. **Educate the public.** Build upon current efforts to educate the general public on best practices to green urban residential areas.

Section II: Preparedness and Response to Extreme Heat Events

1. **Assess state, regional and local hazard mitigation plans, heat contingency plans and other hazard planning documents for potential incorporation and/or refinement of health impacts related to heat event (climate change) projections.**
   Lead Agency: *California Governor's Office of Emergency Services.*
   Other Agencies and Stakeholders: *California Department of Public Health, Cal/OSHA, local emergency managers and planners, local health departments, health care sector.*

   i. Update the State Multi-Hazard Mitigation Plan to include emerging climate change research for potential health impacts to California populations.
   ii. Continue to support state and local government emergency planning efforts and enhance capabilities through multiple means, such as emergency management grants, planning assistance and guidance, mutual aid agreements, mitigation and post-disaster recovery.
   iii. Promote the implementation of the Climate Adaptation Planning Guide (APG) strategies and Cal-Adapt assessments in State and Local Hazard Mitigation Plans and other hazard related plans, including general plan safety elements.
   iv. Promote the emerging climate change research into state and local hazard identification and risk assessment planning efforts.

2. **Improve Heat-Health Alert Warnings.**
   Lead Agency: *California Department of Public Health, Office of Environmental Health Hazard Assessment.*
   Other Agencies and Stakeholders: *Office of State Climatologist - Department of Water Resources, Cal/OSHA, National Weather Service, National Oceanic and Atmospheric Administration, Centers for Disease Control and Prevention.*

   Work collaboratively with the National Weather Service to incorporate health outcomes as a criterion for heat warning products. Leverage technical expertise of California universities and State agencies' staff. Evaluate historical data on mortality and morbidity as a function of heat, to assist in this evaluation of heat warning products.

3. **Improve community resilience from the impacts of increasing heat events, especially for vulnerable populations.**
   Lead Agency: *California Department of Public Health.*
   Other Agencies and Stakeholders: *Office of Environmental Health Hazard Assessment, California Governor's Office of Emergency Services, local health agencies, local emergency management, local social services, local non-governmental organizations.*

   Convene health and social service providers from multiple sectors, including state and local agencies, and researchers who are developing state-of-the-art vulnerability mapping techniques, mitigation and adaptation strategies and other information to:
   i. Identify data sources and best practices for assessing and characterizing vulnerability (maps and other information) in ways that can improve service delivery;

ii. Identify strategies to increase community resilience by improving social infrastructure, such as places and organizations that foster cohesion and support;

iii. Improve or develop outreach strategies for communicating risks to vulnerable communities.

4. **Protect energy systems.**
Lead Agency: *California Energy Commission.*
Other Agencies and Stakeholders: *California Public Utilities Commission, California Department of Public Health, Emergency Medical Services Authority, California Independent System Operator, local governments, local health departments, health care facilities, cooling equipment suppliers.*

   Work with utilities and fuel providers to protect energy supplies (e.g., diesel for backup generators, propane) to cooling centers and other essential services, wherever possible.

5. **Expand energy assurance.**
Lead Agency: *California Energy Commission.*
Other Agencies and Stakeholders: *Governor's Office of Planning and Research.*

   Expand the California Local Energy Assurance Planning program to provide guidance to local jurisdictions on how best to address climate adaptation for the energy sector to provide clean, cost effective, and reliable energy to maintain essential services. Provide information on upstream energy flows (beyond the jurisdiction) and its vulnerabilities to extreme events. Provide guidance on integrating smart energy investments in energy and safety elements of general plans, energy assurance/resiliency plans, and hazard mitigation plans.

6. **Review and improve access to and use of air conditioning and other indoor cooling strategies**
Lead Agency: *California Department of Public Health.*
Other Agencies and Stakeholders: *California Public Utilities Commission, California Occupational Safety and Health, Cal/OSHA, California Governor's Office of Emergency Services, local governments, local energy planners, local public health departments, utilities.*

   i. **Improve access to air conditioning.** Improve the availability of air conditioning to vulnerable populations who do not currently have access.

   ii. **Address obstacles to the use of air conditioning.** Work with local governments and utilities to review the adequacy of programs designed to help vulnerable populations stay cool during heat waves, with attention to ways to offset the economic impacts on seniors and low income groups.

   iii. **Improve messaging about air conditioning.** Coordinate with the Flex Alert program to create a unified message appropriate for extreme heat events.

   iv. **Identify alternatives to air conditioning.** Identify alternatives to grid-powered air conditioners for cooling, such as propane air conditioners, fans and cold water systems.

   v. **Develop indoor air temperature guidelines.** Develop indoor air temperature guidelines for vulnerable populations (e.g., the elderly) which both protect health and may assist with energy efficiency

Section III: Public Health and Health Care Sector Readiness

1. **Increase the health care system's extreme heat preparedness and resiliency.**
   Lead Agency: *California Department of Public Health, Emergency Medical Services Authority.*
   Other Agencies and Stakeholders: *Health and Human Services Agency, Department of Managed Health Care, California Hospital Association, California Association of Health Facilities, local public health departments, state and local health professions organizations.*

   Convene key healthcare agencies and partners representing the health care sector to review this guidance, assess additional risks to the health sector and identify any new or modified strategies necessary to become more heat prepared and resilient.

2. **Improve the timeliness and completeness of heat illness and death surveillance activities in order to understand the impact of heat events and guide real time public health planning and responses.**
   Lead Agency: *California Department of Public Health.*
   Other Agencies and Stakeholders: *Office of Environmental Health Hazard Assessment, Emergency Medical Services Authority, local health departments, hospitals, health care providers, coroners, local emergency medical services.*

   i. Convene key stakeholder and health representatives to identify changes that could improve the State's capacity to detect and monitor health effects during a heat wave.
   ii. Review CDPH's Electronic Death Registration System to determine how it could be modified to include a heat report supplement to collect additional vital information during heat waves.
   iii. Consider whether other early detection surveillance programs might be expanded to include heat illness for statewide surveillance. (e.g., BioSense).
   iv. Examine new developments in the Health Information Exchange that may present opportunities to collect heat illness data from electronic medical records (e.g., use of the early-detection surveillance module).
   v. Identify resources to support more timely and accurate statewide reporting and surveillance of health that can prioritize needs and evaluate the effectiveness of interventions.
   vi. Continue discussions with state public health department personnel and the national Council of State and Territorial Epidemiologists regarding making heat death and/or illness a reportable condition.

Section IV: Measures to Protect Workers at Risk of Extreme Heat

1. **Evaluate Cal/OSHA's Heat Illness Prevention Standard (Title 8, California Code of Regulations, Section 3395) to determine its effectiveness and whether revisions are necessary.**
   Lead Agency: *Cal/OSHA.*
   Other Agencies and Stakeholders: *California Department of Food and Agriculture, California Department of Public Health, labor, business.*

2. **Promote greater coordination by State and local agencies, industry, schools, clinics/ hospitals and media to convey necessary worker protection measures.**
   Lead Agency: *Cal/OSHA.*
   Other Agencies and Stakeholders: *California Department of Food and Agriculture, California Department of Public Health, local health departments, labor, health care providers, business.*

3. **Augment training of employers and workers in industries with outdoor work, including assurance of adequate water, shade, rest breaks and training on heat risks.**
   Lead Agency: *Cal/OSHA.*
   Other Agencies and Stakeholders: *California Department of Food and Agriculture, labor, business.*

4. **Evaluate the effectiveness of engineering and administrative controls to mediate employee exposures to high heat; develop new methods of protection.**
   Lead Agency: *Cal/OSHA.*
   Other Agencies and Stakeholders: *California Department of Food and Agriculture, labor, business.*

Section V: Research Needs

1. **Identify the characteristics of vulnerable populations and communities that are highly resilient to heat.**
   Lead Agency: *California Department of Public Health.*
   Other Agencies and Stakeholders: *Office of Environmental Health Hazard Assessment, Climate Action Team Research Working Group.*

   Identify resilience characteristics. Use statistical approaches to determine vulnerable subgroups (i.e., by race/ethnic group, age, education level, income) for regions or counties.

2. **Identify heat adaptation strategies with health co-benefits.**
   Lead Agency: *California Department of Public Health.*
   Other Agencies and Stakeholders: *Air Resources Board, Office of Environmental Health Hazard Assessment.*

3. **Conduct research on population acclimatization to heat in a changing climate.**
   Lead Agency: *California Department of Public Health.*
   Other Agencies and Stakeholders: *Office of Environmental Health Hazard assessment, academic and medical research partners.*

   Investigate how various populations, especially vulnerable groups, will acclimatize to increasing heat, with a view to incorporating acclimatization into plans to increase adaptive capacity.

4. **Evaluate strategies that could provide protection against heat and air pollution to vulnerable populations that are not based on energy intensive air conditioning.**
   Lead Agency: *California Energy Commission, California Public Utility Commission, Air Resources Board.*
   Other Agencies and Stakeholders: *Cal/OSHA, Building Standards Commission, CAL FIRE, Department of Housing and Community Development, utilities.*

5. **Evaluate occupational health risks and strategies to reduce those risks.**
   Lead Agency: *Cal/OSHA.*
   Other Agencies and Stakeholders: *California Department of Food and Agriculture, California Department of Public Health, Labor, business.*
   i. Evaluate and reduce exposures to process-related heat sources.
   ii. Evaluate work organization such as reducing physically demanding work during hot times of the day, and addressing the work/rest cycle during periods of high heat. This should include identifying and removing factors that discourage workers from taking those rest periods.

6. **Assess the extent and severity of the Urban Heat Island Effect for California cities such that the cities can have a quantifiable goal for reduction.**
   Lead Agency: *California Environmental Protection Agency, Air Resources Board.*
   Other Agencies and Stakeholders: *California Department of Public Health, Caltrans, CAL FIRE, Office of Environmental Health Hazard Assessment, local governments, academic researchers.*

7. **Conduct research to assess life-cycle costs and benefits associated with higher-albedo pavement.**
   Lead Agency: *Caltrans, Air Resources Board.*
   Other Agencies and Stakeholders: *California Environmental Protection Agency.*

8. **Evaluate the effectiveness of early heat warning systems geared toward working populations at high risk.**
   Lead Agency: *Cal/OSHA.*
   Other Agencies and Stakeholders: *California Department of Public Health, Office of Environmental Health Hazard Assessment, California Governor's Office of Emergency Services, Department of Water Resources - Office of State Climatologist.*

9. **Perform high-resolution tree canopy analysis of the state's urban areas.**
   Lead Agency: *CALFIRE.*
   Other Agencies and Stakeholders: *U.S. Forest Service, local governments.*

Resources

Heat and Health

- Public Health Impacts of Climate Change in California: Heat-Related Illness and Mortality, CDPH, 2008. *http://www.ehib.org/papers/Heat_Vulnerability_2007.pdf*

Heat and Occupational Health

- Cal OSHA Heat Standard *http://www.dir.ca.gov/Title8/3395.html*
- Cal OSHA Heat Illness Prevention Materials *http://www.dir.ca.gov/dosh/HeatIllnessInfo.html*

Heat Mitigation, Preparedness and Response Plans

- Cal OES State Hazard Mitigation Plan, 2010 (2013 update) *http://hazardmitigation.calema.ca.gov/docs/2010_SHMP_Final.pdf*
- Cal OES State Contingency Plan for Excessive Heat Emergencies, 2010 *http://develop.oes.ca.gov/WebPage/oeswebsite.nsf/ClientOESFileLibrary/Plans%20and%20Publications/$file/HeatContingencyPlan.pdf*

Public Health and Medical Response Plans

- California Public Health and Medical Operations Manual, Ca. Emergency Medical Services Authority (CDPH and EMSA, 2011) *http://www.emsa.ca.gov/disaster/files/EOM712011.pdf*

Risk Communication for Heat Emergencies

- Communicating the Health Risks of Extreme Heat Events (Health Canada, 2010) *http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/climat/heat-chaleur/heat-chaleur-eng.pdf*
- Extreme Heat Media Toolkit (Centers for Disease Control and Prevention, 2010) *http://www.cdc.gov/nceh/extremeheat/index.html*

Green Building Codes

- CAL Green Building Code *http://www.bsc.ca.gov/home/calgreen.aspx*

Urban Heat Islands

- Reducing Urban Heat Islands Compendium of Strategies (US EPA, 2008) *http://www.epa.gov/heatisland/resources/compendium.htm*
- Lawrence Berkeley National Laboratory –Urban Heat Island Team *http://heatisland.lbl.gov/*
- Global Cool Cities Alliance *http://www.globalcoolcities.org/*
- Adapting to Urban Heat: A Toolkit for Local Governments (Georgetown Climate Center, 2012) *http://www.law.georgetown.edu/academics/academic-programs/clinical-programs/our-clinics/HIP/upload/Urban-Heat-Toolkit_RD2.pdf*

Urban Greening/Urban Forestry

- Cal Fire Urban and Community Forestry page
  http://www.fire.ca.gov/resource_mgt/resource_mgt_urbanforestry.php
- US Forest Service Urban Forestry Program / Pacific Southwest Research Station
  http://www.fs.fed.us/psw/programs/uesd/uep/

Climate Change Adaptation/Readiness Planning Resources

- California Climate Adaptation Planning Guide (4 volumes.) Natural Resources Agency and Cal OES, 2012 *http://resources.ca.gov/climate_adaptation/local_government/adaptation_policy_guide.html*
- California Adaptation Strategy, Natural Resources Agency, 2009 (2013 update in progress)
  http://resources.ca.gov/climate_adaptation/docs/Statewide_Adaptation_Strategy.pdf

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- California Department of Forestry and Fire Protection (CAL FIRE)
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- California Department of Transportation (Caltrans)
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- Office of Environmental Health Hazard Assessment (OEHHA)

9 The Climate Action Team (CAT) members work to coordinate statewide efforts to implement global warming *emission reduction programs* and the state's *Climate Adaptation Strategy*. The *CAT members* are state agency secretaries and the heads of agency, boards and departments, led by the Secretary of Cal/EPA. The CAT oversees nine Working Groups, one of which is the Public Health Workgroup. Its task is to address cross-cutting issues related to climate change and health. The Public Health Workgroup is responsible for providing public health input into the AB 32 implementation process, as well as other public health issues related to climate change mitigation and adaptation.

Other Stakeholders

- California Independent System Operator (CAISO)
- Centers for Disease Control and Prevention (CDC)
- Climate Action Team (CAT)
- Department of Community Services and Development (CSD)
- Department of Conservation (DOC)
- Department of Fish & Wildlife (CDFW)
- Department of Housing and Community Development (HCD)
- Emergency Medical Services Authority (EMSA)
- Health and Human Services Agency (HHS)
- State Water Resources Control Board (SWRCB)
- Strategic Growth Council (SGC)

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For more information, contact:

California Environmental Protection Agency

1001 I Street
P.O. Box 2815
Sacramento, CA 95812
(916) 323-2514
www.calepa.ca.gov

California Department of Public Health

P.O. Box 997377, MS 0500
Sacramento, CA 95899-7377
(916) 558-1784
www.cdph.ca.gov

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