3.4 CLIMATE CHANGE

Emissions of greenhouse gases (GHGs) have the potential to adversely affect the environment because such emissions contribute, on a cumulative basis, to global climate change. The proper context for addressing this issue in an EIR/EIS is within an assessment of cumulative impacts, because although it is unlikely that a single project will contribute significantly to climate change, cumulative emissions from many projects could impact global GHG concentrations and the climate system.

Global climate change also has the potential to result in sea level rise (resulting in flooding of low-lying areas), to affect rainfall and snowfall (leading to changes in water supply), to affect temperatures and habitats (affecting biological resources), and to result in many other adverse effects.

3.4.1 GREENHOUSE GAS EMISSIONS AND CONTRIBUTION TO GLOBAL CLIMATE CHANGE

INTRODUCTION

Cumulative impacts are the collective impacts of one or more past, present, and future projects that, when combined, result in adverse changes to the environment. In determining the significance of a proposed project's contribution to anticipated adverse future conditions, a lead agency should generally undertake a two-step analysis. The first question is whether the *combined* effects from *both* the proposed project *and* other projects would be cumulatively significant. If the agency answers this inquiry in the affirmative, the second question is whether "the proposed project's *incremental* effects are cumulatively considerable" and thus significant in and of themselves.

Legislation and executive orders on the subject of climate change in California have established a statewide context and process for developing an enforceable cap on GHG emissions. Given the nature of environmental consequences from GHGs and global climate change, CEQA requires that lead agencies consider evaluating the cumulative impacts of GHGs. The contributions of project-generated GHG emissions to this cumulative impact (from which significant effects are occurring and are expected to worsen over time) may be potentially significant.

The cumulative global climate change analysis presented in this section of the EIR/EIS includes two subsections: 3.4.1 and 3.4.2. Subsection 3.4.1 contains a discussion of existing climate conditions, the current state of climate change science, and GHG emissions sources in California, as well as a summary of applicable regulations. Next, a description of GHG emissions generated by the Proposed Project and the other four action alternatives, and their contribution to global climate change, is presented. In Subsection 3.4.2, the potential effects of global climate change are identified based on available scientific data, and their potential effects on the project are evaluated to the extent possible based on the quality of the data. Regardless of which of the alternatives were implemented, the impacts of global change on the project would be substantially similar. Consequently, the format of Subsection 3.4.2 is altered in comparison to the other sections in Chapter 3.

AFFECTED ENVIRONMENT

Existing Climate

Climate is the accumulation of daily and seasonal weather events over a long period of time, whereas weather is defined as the condition of the atmosphere at any particular time and place (Ahrens 2003). The SPA is located in a climatic zone characterized as dry-summer subtropical or Mediterranean (abbreviated Cs) on the Köppen climate classification system. The Köppen system's classifications are primarily based on annual and monthly averages of temperature and precipitation.

The Sacramento Valley Air Basin (SVAB) is relatively flat, bordered by mountains to the east, west, and north. Air flows into the SVAB through the Carquinez Strait, the only breach in the western mountain barrier, and moves across the Sacramento–San Joaquin River Delta, bringing with it pollutants from the heavily populated San Francisco Bay Area. The climate is characterized by hot, dry summers and cool, rainy winters.

Periods of dense and persistent low-level fog that are most prevalent between storms are characteristic of SVAB winter weather. The average winter temperature is a moderate 49 degrees Fahrenheit (°F). Most precipitation in the area results from air masses that move in from the Pacific Ocean from the west or northwest during the winter rainy season (November–April). During the summer, daily temperatures range from 50°F to more than 100°F. The inland location and surrounding mountains shelter the area from much of the ocean breezes that keep the coastal regions moderate in temperature.

The local meteorology of the SPA is represented by measurements recorded at the Sacramento 5 ESE station, near California State University, (CSU), Sacramento. The normal annual precipitation, which occurs primarily from November through April, is approximately 18 inches (Western Regional Climate Center [WRCC] 2010a). January temperatures range from an average minimum of 40°F to an average maximum of 53°F. July temperatures range from an average minimum of 59°F to an average maximum of 92°F (WRCC 2010a). The predominant wind direction and speed is from the south-southwest at approximately 8 miles per hour (mph) (WRCC 2010b; National Climatic Data Center [NCDC] 2010).

Attributing Climate Change—The Physical Scientific Basis Certain gases in the earth's atmosphere, classified as GHGs play a critical role in determining the earth's surface temperature. Solar radiation enters the earth's atmosphere from space. A portion of the radiation is absorbed by the earth's surface, and a smaller portion of this radiation is reflected back toward space. The radiation absorbed by the earth is re-radiated, not as high-frequency solar radiation, but lower frequency infrared radiation. The frequencies at which bodies emit radiation are proportional to temperature. The earth has a much lower temperature than the sun; therefore, the earth emits lower frequency (longer wavelength) radiation. Most solar radiation passes through GHGs; however, infrared radiation is selectively absorbed by GHGs. As a result, infrared radiation released from the earth that otherwise would have escaped back into space is instead "trapped," resulting in a warming of the atmosphere. This phenomenon, known as the "greenhouse effect," is responsible for maintaining a habitable climate on Earth. Without the greenhouse effect, Earth would not be able to support life as we know it.

Prominent GHGs contributing to the greenhouse effect are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and high global warming potential (high-GWP) GHGs. High-GWP GHGs include ozone depleting substances (ODSs), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and halons, in addition to their replacements, hydrofluorocarbons (HFCs). Other high-GWP GHGs include perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Anthropogenic (i.e., caused by humans) emissions of these GHGs leading to atmospheric levels in excess of natural ambient concentrations are responsible for intensifying the greenhouse effect and have led to a trend of unnatural warming of the earth's atmosphere and oceans, with corresponding effects on global circulation patterns and climate (United Nations Intergovernmental Panel on Climate Change [IPCC] 2007:665). Carbon dioxide emissions associated with fossil fuel combustion are the primary contributors to human-induced climate change (EPA 2010a). Following CO_2, CH_4 and N_2O emissions associated with human activities are the next largest contributors to climate change (IPCC 2007:135; U.S. Environmental Protection Agency [EPA] 2010b:ES-4–ES-10).

Climate change is a global problem because GHGs are global pollutants, unlike criteria air pollutants and toxic air contaminants (TACs), which are pollutants of regional and local concern. Whereas pollutants with localized air quality effects have relatively short atmospheric lifetimes (about one day), GHGs have long atmospheric lifetimes (one year to several thousand years). GHGs persist in the atmosphere for a long enough time to be dispersed around the globe. Although the exact lifetime of any particular GHG molecule depends on multiple variables and cannot be pinpointed, more CO_2 is currently emitted into the atmosphere than is sequestered. Carbon dioxide sinks, or reservoirs, include vegetation and the ocean, which absorb CO_2 through photosynthesis and dissolution, respectively. These are two of the most common processes of CO_2 sequestration. Of the total annual human-caused CO_2 emissions, approximately 54% is sequestered through ocean uptake, northern hemisphere forest regrowth, and other terrestrial sinks within a year, whereas the remaining 46% of human-caused CO_2 emissions remain stored in the atmosphere (Seinfeld and Pandis 1998:1091).

Similarly, effects of GHGs are borne globally, as opposed to localized air quality effects of criteria air pollutants and TACs. The quantity of GHGs that it takes to ultimately result in climate change is not precisely known; suffice it to say that the quantity is enormous, and no single project would be expected to measurably contribute to a noticeable incremental change in the global average temperature, or to global, local, or micro-climate.

Attributing Climate Change—Greenhouse Gas Emissions Sources

Emissions of GHGs contributing to global climate change are attributable in large part to human activities associated with the transportation, industrial/manufacturing, utility, residential, commercial and agricultural emissions sectors (California Air Resources Board [ARB] 2010a). In California, the transportation sector is the largest emitter of GHGs, followed by electricity generation (ARB 2010a).

Emissions of CO_2 are byproducts of fossil fuel combustion. Methane, a highly potent GHG, results from off-gassing (the release of chemicals from nonmetallic substances under ambient or greater pressure conditions) and is largely associated with agricultural practices and landfills. Nitrous oxide is also largely attributable to agricultural practices and soil management. Carbon dioxide sinks, or reservoirs, include vegetation and the ocean, which absorb CO_2 through sequestration and dissolution, respectively, two of the most common processes of CO_2 sequestration.

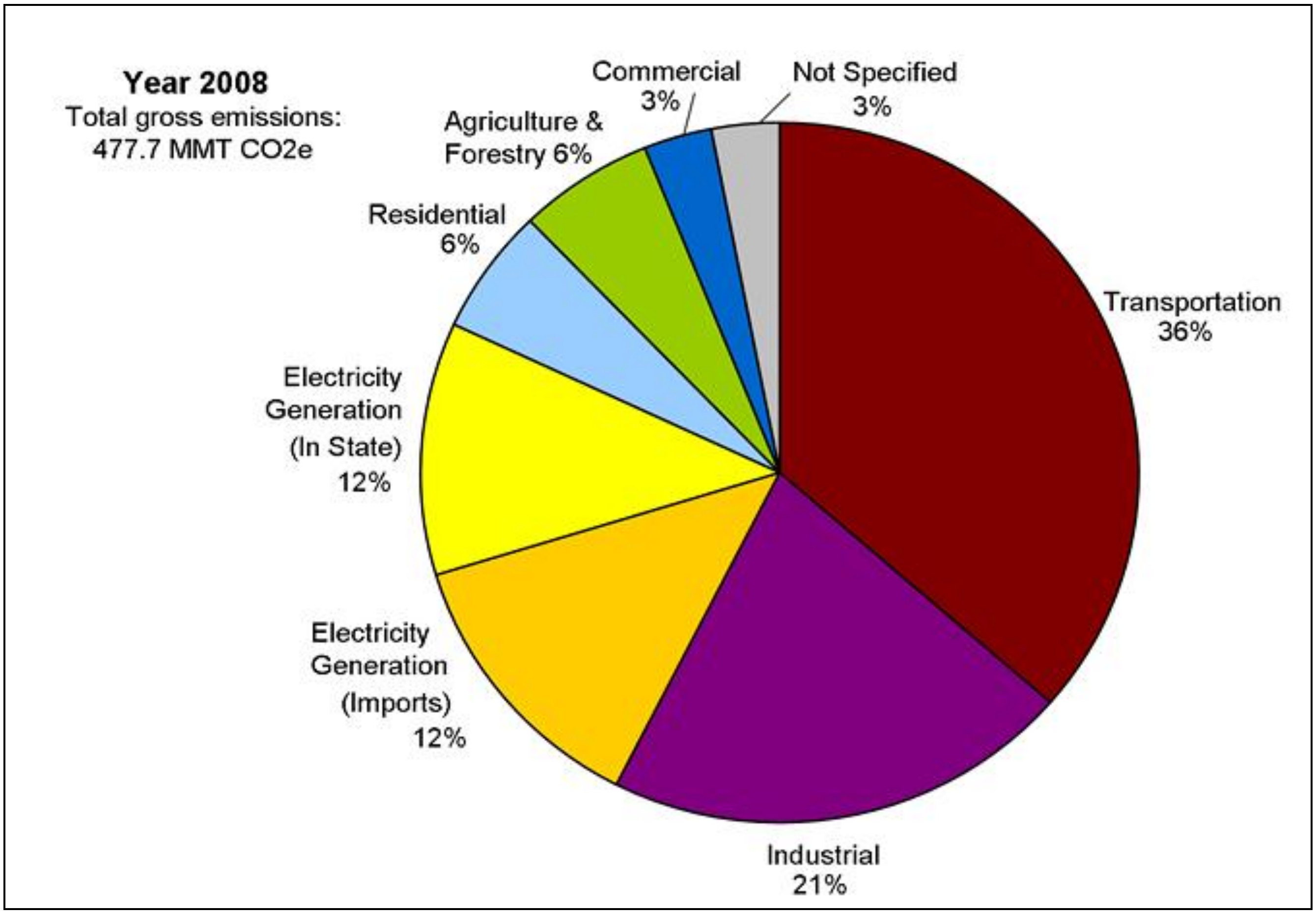
Land use decisions and development projects are not themselves GHG emissions sectors. In other words, land use development projects can generate GHG emissions from several sectors (e.g., transportation, electricity, and waste), as described in more detail below. Land use decisions and development projects can affect the generation of GHG emissions from multiple sectors that result from their implementation. Development projects can result in direct or indirect GHG emissions that would occur on- or off-site. For example, electricity consumed in structures within a project would indirectly cause GHGs to be emitted at a utility provider. The residents of, and the visitors to a development project would drive vehicles that generate off-site GHG emissions, which are associated with the transportation sector. The following sections describe the major GHG emission sectors and their associated emissions at the state and local level.

State Greenhouse Gas Emissions Inventory

As the second largest emitter of GHG emissions in the United States and twelfth to sixteenth largest in the world, California contributes a significant quantity of GHGs to the atmosphere (CEC 2006b:i). Emissions of CO_2 are byproducts of fossil-fuel combustion and are attributable in large part to human activities associated with the transportation, industry/manufacturing, electricity and natural gas consumption, and agriculture (ARB 2010a). In California, the transportation sector is the largest emitter of GHGs, followed by electricity generation (ARB 2010a) (see Exhibit 3.4.1-1, below).

GHGs with lower emissions rates than CO_2 may still contribute to climate change because they are more effective at absorbing outgoing infrared radiation than CO_2. The concept of CO_2 equivalency (CO_2e) is used to account for the different potentials of GHGs to absorb infrared radiation. This potential, known as the GWP of a GHG, is dependent on the lifetime, or persistence, of the gas molecule in the atmosphere.

Emissions of CH_4 and N_2O are generally much lower than those of CO_2, and are associated with anaerobic microbial activity resulting from agricultural practices, flooded soils, and landfills. These two compounds, CH_4 and N_2O, have approximately 23 and 296 times the GWP of CO_2, respectively.



Source: ARB 2010a

2008 California GHG Emissions by Sector (2000–2008 Emissions Inventory) **Exhibit 3.4-1**

Local Inventory

A GHG emissions inventory was conducted for each incorporated city in Sacramento County, including the City of Rancho Cordova (City), and the unincorporated area of Sacramento County (County) for the year 2009 (ICF Jones & Stokes 2009). The City's communitywide GHG Emissions totaled approximately 557,943 metric tons of CO_2e in 2005, or about 4% of the GHG emissions generated in Sacramento County. On-road transportation emissions accounted for 45% of the City's GHG emissions, followed by 24% from commercial/industrial land uses, and 17% from residential uses (ICF Jones & Stokes 2009).

REGULATORY FRAMEWORK

Numerous Federal, state, regional, and local laws, rules, regulations, plans, and policies define the framework that regulates and will potentially regulate climate change. The following discussion focuses on climate change requirements applicable to the project.

Federal Plans, Policies, Regulations, and Laws

Supreme Court Ruling on California Clean Air Act Waiver

The EPA is the Federal agency responsible for implementing the Federal Clean Air Act (CAA). The U.S. Supreme Court ruled on April 2, 2007 that CO_2 is an air pollutant as defined under the CAA, and that EPA has the authority to regulate emissions of GHGs. However, there are no Federal regulations or policies regarding GHG emissions applicable to the Proposed Project or other alternatives under consideration. See Assembly Bill (AB) 1493 for further information on the California Clean Air Act (CCAA) Waiver.

Energy and Independence Security Act of 2007 and Corporate Average Fuel Economy Standards

The Energy and Independence Security Act of 2007 (EISA) amended the Energy Policy and Conservation Act (EPCA) to further reduce fuel consumption and expand production of renewable fuels. The EISA's most important amendment includes a statutory mandate for the National Highway Traffic Safety Administration (NHTSA) to set passenger car corporate average fuel economy (CAFE) standards for each model year (MY) at the maximum feasible level. This statutory mandate also eliminates the old default CAFE standard of 27.5 miles per gallon (mpg). The EISA requires that CAFE standards for MY 2011-2020 be set sufficiently high to achieve the goal of an industry-wide passenger car and light-duty truck average CAFE standard of 35 mpg. The rule making for this goal, per President Obama's request, has been divided into two separate parts. The first part, which was published in the Federal Register in March 2009, includes CAFE standards for MY 2011 in order to meet the statutory deadline (i.e., March 30, 2009). The second part of the rulemaking applies to MY 2012 and subsequent years. These would be the maximum CAFE standards feasible under the limits of the EPCA and EISA. The NHTSA and the EPA are currently working in coordination to develop a national program targeting MY 2012–2016 passenger cars and light trucks.

EPA Proposed Regulations

In response to the mounting issue of climate change, EPA has taken the following actions to regulate, monitor, and potentially reduce GHG emissions.

Proposed Mandatory Greenhouse Gas Reporting Rule

On September 22, 2009, EPA issued a final rule for mandatory reporting of GHGs from large GHG emissions sources in the United States. In general, this national reporting requirement will provide EPA with accurate and timely GHG emissions data from facilities that emit 25,000 metric tons (MT) or more of CO_2 per year. This publically available data will allow the reporters to track their own emissions, compare them to similar facilities, and aid in identifying cost-effective opportunities to reduce emissions in the future. Reporting is at the facility level, except that certain suppliers of fossil fuels and industrial GHG emitters, along with vehicle and engine manufacturers, will report at the corporate level. An estimated 85% of the total U.S. GHG emissions, from approximately 10,000 facilities, are covered by this final rule.

National Program to Cut Greenhouse Gas Emissions and Improve Fuel Economy for Cars and Trucks

On September 15, 2009, EPA and the U.S. Department of Transportation's NHTSA proposed a new national program that would reduce GHG emissions and improve fuel economy for all new cars and trucks sold in the United States. EPA proposed the first-ever national GHG emissions standards under the CAA, and NHTSA proposed Corporate Average Fuel Economy standards under the Energy Policy and Conservation Act. This proposed national program would allow automobile manufacturers to build a single light-duty national fleet that satisfies all requirements under both Federal programs and the standards of California and other states.

Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the Federal Clean Air Act

On December 7, 2009, EPA adopted its *Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases* under the CAA (Endangerment Finding). The Endangerment Finding is based on Section 202(a) of the CAA, which states that the EPA Administrator should regulate and develop standards for "emission[s] of air pollution from any class of classes of new motor vehicles or new motor vehicle engines, which in [its] judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare." The rule addresses Section 202(a) in two distinct findings. The first addresses whether or not the concentrations of the six key GHGs (i.e., CO_2, CH_4, N_2O, HFCs, perfluorocarbons, and SF_6) in the atmosphere threaten the health and welfare of current and future generations. The second addresses whether or not the combined emissions of GHGs from new motor vehicles and motor vehicle engines contribute to atmospheric concentrations of GHGs and thus to the threat of climate change.

The EPA Administrator found that atmospheric concentrations of GHGs endanger public health and welfare within the meaning of Section 202(a) of the CAA. The EPA Administrator also found that GHG emissions from new motor vehicles and motor vehicle engines are contributing to air pollution, which is endangering public health and welfare.

Council on Environmental Quality Draft National Environmental Policy Act Guidelines

Because of uneven treatment of climate change under NEPA, the International Center for Technology Assessment (ICTA), Natural Resources Defense Council (NRDC), and Sierra Club filed a petition with the Council on Environmental Quality (CEQ) in March 2008, requesting inclusion of climate change analyses in all Federal environmental review documents. In response to the petition, as well as Executive Order 13514, the CEQ issued new draft guidance on when and how to include GHG emissions and climate change impacts in environmental review documents under NEPA. The CEQ's guidance (issued on February 18, 2010) suggests that Federal agencies should consider opportunities to reduce GHG emissions caused by proposed Federal actions and adapt their actions to climate change impacts throughout the NEPA process and to address these issues in their agency NEPA procedures.

In the context of addressing climate change in environmental documentation, the two main considerations are:

1. The GHG emissions effects of a proposed action and alternative actions, and

2. The impacts of climate change on a proposed action or alternatives. The CEQ notes that "significant" national policy decisions with "substantial" GHG impacts require analysis of their GHG effects, i.e., if a proposed action causes "substantial" annual direct emissions, or if a Federal agency action implicates energy conservation, reduced energy use or GHG emissions, and/or promotes renewable energy technologies that are cleaner and more efficient.

In these circumstances, information on GHG emissions (qualitative or quantitative) that is useful and relevant to the decision should be used when deciding among alternatives. The CEQ suggests that if a proposed action causes direct annual emissions of $\geq$ 25,000 MT CO_2e, a quantitative and qualitative assessment may be meaningful to decision makers and the public. If annual direct emissions are less than 25,000 MT CO_2e, the CEQ encourages Federal agencies to consider whether the action's long-term emissions should receive similar analyses.

State Plans, Policies, Regulations, and Laws

Because every nation emits GHGs and thus makes an incremental cumulative contribution to global climate change, cooperation on a global scale will be required to reduce the rate of GHG emissions to a level that can help to slow or stop the human-caused increase in average global temperatures and associated changes in climatic conditions. Several statewide initiatives relevant to land use planning are discussed below; however, this does not represent a complete list of climate change-related legislation in California.

Assembly Bill 1493

In 2002, then-Governor Gray Davis signed AB 1493. AB 1493 requires that ARB develop and adopt, by January 1, 2005, regulations that achieve "the maximum feasible reduction of greenhouse gases emitted by passenger vehicles and light-duty trucks and other vehicles determined by ARB to be vehicles whose primary use is noncommercial personal transportation in the state."

To meet the requirements of AB 1493, in 2004 ARB approved amendments to the California Code of Regulations (CCR) adding GHG emissions standards to California's existing standards for motor vehicle emissions. Amendments to CCR Title 13, Sections 1900 and 1961 (13 CCR 1900, 1961), and adoption of Section 1961.1 (13 CCR 1961.1) require automobile manufacturers to meet fleet-average GHG emissions limits for all passenger cars, light-duty trucks within various weight criteria, and medium-duty passenger vehicle weight classes (i.e., any medium-duty vehicle with a gross vehicle weight rating less than 10,000 pounds that is designed primarily for the transportation of persons), beginning with the 2009 model year. For passenger cars and light-duty trucks with a loaded vehicle weight (LVW) of 3,750 pounds or less, the GHG emission limits for the 2016 model year are approximately 37% lower than the limits for the first year of the regulations, the 2009 model year. For light-duty trucks with LVW of 3,751 pounds to gross vehicle weight (GVW) of 8,500 pounds, as well as medium-duty passenger vehicles, GHG emissions would be reduced approximately 24% between 2009 and 2016.

In December 2004, a group of car dealerships, automobile manufacturers, and trade groups representing automobile manufacturers filed suit against ARB to prevent enforcement of 13 CCR Sections 1900 and 1961 as amended by AB 1493 and 13 CCR 1961.1 (*Central Valley Chrysler-Jeep et al. v. Catherine E. Witherspoon, in Her Official Capacity as Executive Director of the California Air Resources Board, et al.*). The automobile-makers' suit in the U.S. District Court for the Eastern District of California, contended California's implementation of regulations that, in effect, regulate vehicle fuel economy, violates various Federal laws, regulations, and policies.

On December 12, 2007, the court found that if California receives appropriate authorization from EPA (the last remaining factor in enforcing the standard), then these regulations would be consistent with and have the force of Federal law, thus, rejecting the automobile-makers' claim. This authorization to implement more stringent standards in California was requested in the form of a CAA Section 209(b), waiver in 2005. Since that time, EPA failed to act on granting California authorization to implement the standards. Governor Schwarzenegger and Attorney General Edmund G. Brown filed suit against EPA for the delay. In December 2007, EPA Administrator Stephen Johnson denied California's request for the waiver to implement AB 1493. Johnson cited the need for a national approach to reducing GHG emissions, the lack of a "need to meet compelling and extraordinary conditions," and the emissions reductions that would be achieved through the Energy Independence and Security Act of 2007 as the reasoning for the denial (Office of the White House 2009).

The State of California filed suit against EPA for its decision to deny the CAA waiver. Under the Obama administration, EPA was directed to reexamine its position for denial of California's CAA waiver and for its past opposition to GHG emissions regulation. California received the waiver on June 30, 2009.

Executive Order S-3-05

Executive Order S-3-05, which was signed by Governor Schwarzenegger in 2005, proclaims that California is vulnerable to the impacts of climate change. It declares that increased temperatures could reduce the Sierra Nevada snowpack, further exacerbate California's air quality problems, and potentially cause a rise in sea level. To combat those concerns, the Executive Order established total GHG emission targets. Specifically, emissions are to be reduced to the 2000 level by 2010, the 1990 level by 2020, and to 80% below the 1990 level by 2050.

The Executive Order directed the Secretary of the California Environmental Protection Agency (CalEPA) to coordinate a multiagency effort to reduce GHG emissions to the target levels. The Secretary must also submit biannual reports to the Governor and State Legislature describing: progress made toward reaching the emission targets; impacts of global warming on California's resources; and mitigation and adaptation plans to combat these impacts. To comply with the Executive Order, the Secretary of the CalEPA created the California Climate Action Team (CCAT) made up of members from various state agencies and commission. CCAT released its first report in March 2006. The report proposed to achieve the targets by building on voluntary actions of California businesses, local government and community actions, as well as through state incentive and regulatory programs.

Assembly Bill 32, the California Global Warming Solutions Act of 2006

In September 2006, Governor Arnold Schwarzenegger signed AB 32, the California Global Warming Solutions Act of 2006. AB 32 establishes regulatory, reporting, and market mechanisms to achieve quantifiable reductions in GHG emissions and a cap on statewide GHG emissions. AB 32 requires that statewide GHG emissions be reduced to 1990 levels by 2020. This reduction will be accomplished through an enforceable statewide cap on GHG emissions that will be phased in starting in 2012. To effectively implement the cap, AB 32 directs ARB to develop and implement regulations to reduce statewide GHG emissions from stationary sources. AB 32 specifies that regulations adopted in response to AB 1493 should be used to address GHG emissions from vehicles. However, AB 32 also includes language stating that if the AB 1493 regulations cannot be implemented, then ARB should develop new regulations to control vehicle GHG emissions under the authorization of AB 32.

AB 32 requires that ARB adopt a quantified cap on GHG emissions representing 1990 emissions levels and disclose how it arrives at the cap; institute a schedule to meet the emissions cap; and develop tracking, reporting, and enforcement mechanisms to ensure that the state achieves the reductions in GHG emissions necessary to meet the cap. AB 32 also includes guidance to institute emissions reductions in an economically efficient manner and conditions to ensure that businesses and consumers are not unfairly affected by the reductions.

Senate Bill 1368

Senate Bill (SB) 1368 is the companion bill of AB 32 and was signed by Governor Schwarzenegger in September 2006. SB 1368 requires the California Public Utilities Commission (CPUC) to establish a GHG performance standard for baseload generation from investor-owned utilities by February 1, 2007. The CEC must establish a similar standard for local publicly owned utilities by June 30, 2007. These standards cannot exceed the GHG emission rate from a baseload combined-cycle natural gas fired plant. The legislation further requires that all electricity provided to California, including imported electricity, must be generated from plants that meet the standards set by the CPUC and CEC.

Executive Order S-1-07

Executive Order S-1-07, which was signed by Governor Schwarzenegger in 2007, proclaims that the transportation sector is the main source of GHG emissions in California, at over 40% of statewide emissions. It establishes a goal that the carbon intensity of transportation fuels sold in California should be reduced by a minimum of 10% by 2020. This order also directed ARB to determine if this Low Carbon Fuel Standard (LCFS) could be adopted as a discrete early action measure after meeting the mandates in AB 32. ARB adopted the LCFS on April 23, 2009.

Senate Bill 97

SB 97, signed August 2007, acknowledges that climate change is a prominent environmental issue that requires analysis under CEQA. This bill directs the California Office of Planning and Research (OPR) to prepare, develop, and transmit to the California Natural Resources Agency (CNRA) guidelines for the feasible mitigation of GHG emissions or the effects of GHG emissions, as required by CEQA by July 1, 2009. The CNRA adopted those guidelines on December 30, 2009, and the guidelines became effective March 18, 2010.

Senate Bill 375

SB 375, signed in September 2008, aligns regional transportation planning efforts, regional GHG emission reduction targets, and land use and housing allocation. SB 375 requires Metropolitan Planning Organizations (MPOs) to adopt a Sustainable Communities Strategy (SCS) or Alternative Planning Strategy (APS), which will prescribe land use allocation in that MPO's Regional Transportation Plan (RTP). ARB, in consultation with MPOs, will provide each affected region with reduction targets for GHGs emitted by passenger cars and light trucks in the region for the years 2020 and 2035. These reduction targets will be updated every 8 years, but can be updated every 4 years if advancements in emissions technologies affect the reduction strategies to achieve the targets. ARB is also charged with reviewing each MPO's SCS or APS for consistency with its assigned targets. If MPOs do not meet the GHG emission reduction targets, transportation projects would not be eligible for funding programmed after January 1, 2012.

This bill also extends the minimum time period for the Regional Housing Needs Allocation (RNHA) cycle from 5 years to 8 years for local governments located within an MPO that meets certain requirements. City or County land use policies (including general plans) are not required to be consistent with the RTP (and associated SCS or APS). However, new provisions of CEQA would incentivize qualified projects that are consistent with an approved SCS or APS, categorized as "transit priority projects."

Assembly Bill 32, Climate Change Scoping Plan

On December 11, 2008 ARB adopted its *Climate Change Scoping Plan* (Scoping Plan), which functions as a roadmap of ARB's plans to achieve GHG reductions in California required by AB 32 through subsequently enacted regulations (ARB 2008). The Scoping Plan contains the main strategies California will implement to reduce CO_2e emissions to 1990 levels by 2020. The Scoping Plan also breaks down the amount of GHG emissions reductions ARB recommends for each emissions sector of the state's GHG inventory. The Scoping Plan calls for the largest reductions in GHG emissions to be achieved by implementing the following measures and standards:

- improved emissions standards for light-duty vehicles (estimated reductions of 31.7 million metric tons (MMT) CO_2e),
- the LCFS (15.0 MMT CO_2e),
- energy efficiency measures in buildings and appliances and the widespread development of combined heat and power systems (26.3 MMT CO_2e), and
- a renewable portfolio standard for electricity production (21.3 MMT CO_2e).

ARB has not yet determined what amount of GHG emissions reductions it recommends from local government land use decisions; however, the Scoping Plan does state that successful implementation of the plan relies on local governments' land use planning and urban growth decisions because local governments have primary authority to plan, zone, approve, and permit land development to accommodate population growth and the changing needs of their jurisdictions. ARB further acknowledges that decisions on how land is used will have large effects on the GHG emissions that will result from the transportation, housing, industry, forestry, water, agriculture, electricity, and natural gas emission sectors. The Scoping Plan states that the ultimate assignment to local government operations is to be determined (ARB 2008).

The Scoping Plan expects a reduction of approximately 5.0 MMT CO_2e from local land use changes associated with implementation of SB 375, discussed above. The Scoping Plan does not include any direct discussion about GHG emissions generated by construction activity.

Addressing Climate Change at the Project Level: California Attorney General's Office

In January, 2010, the California Attorney General's Office released a document to assist local agencies with addressing climate change and sustainability at the project level under CEQA. The document provides examples of various measures that may reduce the impacts related to climate change at the individual project level. As appropriate, the measures can be included as design features of a project, required as changes to the project, or imposed as mitigation (whether undertaken directly by the project proponent or funded by mitigation fees).

Regional and Local Plans, Policies, Regulations, and Ordinances

Sacramento County

Sacramento County's Board of Supervisors has approved the first phase of a climate action plan that will provide a framework for reducing GHG emissions. The first phase focuses on the County's overall strategy and goals for addressing climate change (Sacramento County 2009). Key goals in the first phase include a reduction in vehicle miles traveled (VMT) per capita in the region; improving energy efficiency of all existing and new buildings; emphasizing water use efficiency as a way to reduce energy consumption; maximizing waste diversion, composting, and recycling through residential and commercial programs; and protecting important farmlands and open space from conversion and encroachment and maintaining connectivity of protected areas.

City of Rancho Cordova

The City of Rancho Cordova has not developed a climate action plan or similar GHG emissions reduction plan for GHG emission-generating activity in its jurisdiction. The City of Rancho Cordova's General Plan does not contain any goals or policies that relate directly to climate change or GHGs, as it was prepared and adopted prior to AB 32 (City of Rancho Cordova 2006). However, as described in Appendix K, there are many policies in the City General Plan that will result in the reduction of GHG emissions even though they were not specifically adopted for that purpose (e.g., policies that reduce emissions of criteria air pollutants and vehicle trips and promote smart growth).

ENVIRONMENTAL CONSEQUENCES AND MITIGATION MEASURES

Thresholds of Significance

Neither the ARB nor the Sacramento Metropolitan Air Quality Management District (SMAQMD) has identified a significance threshold for analyzing GHG emissions associated with a land use development projects. SMAQMD has updated its CEQA guidance, and it released its *Guide to Air Quality Assessment in Sacramento County* in December 2009 (SMAQMD 2009a). However, SMAQMD does not include any numeric GHG significance thresholds in their guide. Instead, SMAQMD suggests that lead agencies identify thresholds of significance applicable to a proposed project that are supported by substantial evidence (SMAQMD 2009a:6-5). Nevertheless, the primary focus of SMAQMD's guidance for addressing GHG emissions is "to provide guidance about evaluating whether the GHG emissions associated with a proposed project would be a cumulatively considerable contribution to global climate change" (SMAQMD 2009a:6-3).

By adoption of AB 32 and SB 97, the State of California has identified GHG emission reduction goals and that the effect of GHG emissions as they relate to global climate change is an adverse environmental impact. While the emissions of one single project will not cause global climate change, GHG emissions from multiple projects throughout the world could result in a cumulative impact with respect to global climate change.

To meet AB 32 goals, California would need to reduce GHG emissions from current levels. It is recognized, however, that for most projects there is no simple metric available to determine if a single project would substantially increase or decrease overall GHG emission levels.

Although the text of AB 32 applies to stationary sources of GHG emissions, this mandate demonstrates California's commitment to reducing the rate of GHG emissions and the state's associated contribution to climate change, without intent to limit population or economic growth within the state. Thus, to achieve the goals of AB 32, which are tied to GHG emission rates of a specific benchmark year (i.e., 1990), California would have to achieve a lower rate of emissions. Further, to accommodate *future* population and economic growth, the state would have to achieve an even lower rate of emissions than was achieved in 1990. (The goal to achieve 1990 quantities of GHG emissions by 2020 means that this will need to be accomplished in the face of 30 years of population and economic growth beyond 1990.) Thus, future planning efforts that would not encourage reductions in GHG emissions or not enable land uses to operate in a GHG-efficient manner would conflict with the policy decisions contained in the spirit of AB 32, thus impeding California's ability to comply with the mandate.

If a statewide context for addressing GHG emissions is applied, any net increase in GHG emissions within state boundaries would be considered "new" emissions. A land development plan, such as the SunCreek Specific Plan, does not create "new" emitters of GHGs, but would theoretically accommodate a greater number of residents and employees in the state. Some of the residents and employees that move to, or work within the project could already be residents and employees in California, while others may be from out-of-state (or would "take the place" of in-state residents who "vacate" their current residences to move to the new project site). The out-of-state residents would be contributing new emissions in a statewide context, but would not necessarily be generating new emissions in a global context. Given the statewide context established by AB 32, the project would need to accommodate an increase in population and employment in a manner that would not inhibit the state's ability to achieve the goals of lower emissions overall.

The State of California has established GHG emission reduction targets and has determined that GHG emissions as they relate to global climate change are a source of adverse environmental impacts in California that should be addressed under CEQA. AB 32 identifies the myriad of environmental problems in California caused by global warming (California Health and Safety Code, Section 38501[a]). Senate Bill 97directed OPR to prepare revisions to the State CEQA Guidelines addressing the mitigation of GHGs or their consequences.

As an interim step toward development of required guidelines, in June 2008, OPR published a technical advisory, entitled *CEQA and Climate Change: Addressing Climate Change through California Environmental Quality Act (CEQA) Review* (OPR 2008). In this technical advisory, OPR recommends that the lead agencies under CEQA make a good-faith effort, based on available information, to estimate the quantity of GHG emissions that would be generated by a proposed project, including the emissions associated with vehicular traffic, energy consumption, water usage, and construction activities, to determine whether the impacts have the potential to result in a project or cumulative impact and to mitigate the impacts where feasible mitigation is available.

OPR's technical advisory also acknowledges that "perhaps the most difficult part of the climate change analysis will be the determination of significance," and noted that "OPR has asked ARB technical staff to recommend a method for setting thresholds which will encourage consistency and uniformity in the CEQA analysis of GHG emissions throughout the state." ARB has not yet completed this task at the time of writing this EIR/EIS.

The thresholds for determining the significance of impacts for this analysis are based on the *CEQA Guidelines* amendments (environmental checklist in Appendix G of the State CEQA Guidelines, as amended). These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and the intensity of its impacts. An impact related to global climate change (i.e., the projected GHG emissions generated by the project) is considered significant if the Proposed Project or other alternatives under consideration would do any of the following:

- generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment; or,

- conflict with any applicable plan, policy or regulation of an agency adopted for the purpose of reducing the emissions of greenhouse gases.

SMAQMD also recommends that the GHG analysis of an EIR address the above two criteria (SMAQMD 2009a:6-6).

At the time of this writing, neither ARB nor SMAQMD have adopted quantitative thresholds of significance for GHG emissions. Therefore, to establish additional context in which to consider the order of magnitude of the project's construction-related and operational GHG emissions, this analysis takes into account the following considerations about what levels of GHG emissions constitute a cumulatively considerable incremental contribution to climate change:

- Facilities (i.e., stationary, continuous sources of GHG emissions) that generate greater than 25,000 MT CO_2e per year are mandated to report their GHG emissions to ARB pursuant to AB 32.

- Stationary sources that generate greater than 10,000 MT CO_2 per year may be required to participate in the cap-and-trade program through the Western Climate Initiative (ARB 2009d).

It is not the City's intent to adopt the above-listed emission levels as a numeric threshold. Rather, the intent is to put project-generated GHG emissions into the appropriate statewide context in order to evaluate whether the GHG emissions contribution resulting from construction and operation of the SunCreek project would result in a cumulatively considerable incremental contribution to the cumulative impact of global climate change.

SMAQMD's CEQA guidance states that the finite amount of a project's construction-related GHG emissions and the operational GHG emissions generated per year over the lifetime of the project should be disclosed separately, and that lead agencies may decide to amortize the level of short-term construction emissions over the expected (long-term) operational life of a project. Operational life of a building can be estimated to be 40 years for new residential and 25 years for conventional commercial (SMAQMD 2009:6-8). SMAQMD recommends Best Management Practices (BMPs) for mitigation of construction-generated GHGs, which are discussed in "Impact Analysis."

SMAQMD does not have adopted thresholds or specific guidance regarding setting of thresholds, other than the following: (1) the adopted threshold should convey information about a project's GHG emissions to the public and lead agency in an appropriate, meaningful, and consistent context, and (2) the metric should provide a useful means by which to compare one project to another and also evaluate whether a project is consistent with statewide goals (SMAQMD 2009:6-9).

For program-level analyses (for general and specific plans), SMAQMD's CEQA guidance recommends that thresholds of significance for GHG emissions be related to AB 32's GHG reduction goals. For example, a numeric GHG reduction target representative of 1990 levels despite planned population and employment growth (e.g., 30 percent below current levels) may be adopted as a policy within the lead agency's general or area plan (SMAQMD 2009:9-9).

SMAQMD also states that another possible threshold option could include the determination of whether the population and employment growth and resultant GHG emissions of the proposed plan are consistent with the state's strategy to achieve the 2020 GHG emissions limit, as outlined in the Scoping Plan. A lead agency could set a threshold using an efficiency-based GHG metric such as per-capita emissions, per-job emissions, or a "service population" metric that combines per-capita and per-job emissions, or other similar metrics. (SMAQMD 2009:9-9).

A lead agency may rely on a Climate Action Plan for CEQA analysis of greenhouse gases for projects if certain criteria are met (please refer to CEQA Guidelines Section 15183.5 for more information).

For the purposes of this EIR/EIS, the net change in GHG emissions associated with the project are quantified and used as a criterion to determine whether the associated emissions would substantially help or hinder the state's ability to attain the goals identified in AB 32 (i.e., reduction of statewide GHG emissions to 1990 levels by 2020).

The analysis of GHG emissions in this EIR/EIS recognizes that the impact that GHG emissions have on global climate change does not depend on whether they are generated by stationary, mobile, or area sources, or whether they are generated in one region or another. As stated above, the mandate of AB 32 demonstrates California's commitment to reducing GHG emissions and the state's associated contribution to climate change, without intending to limit population or economic growth within the state. Thus, to achieve the goals of AB 32, which are tied to mass GHG emission levels of a specific benchmark year (i.e., 1990), California would have to achieve a lower rate of emissions per unit of population (per person) and/or per level of economic activity (e.g., per job) than its current rate. Furthermore, to accommodate future population and economic growth, the state would have to achieve an even lower rate of emissions per unit than it achieved in 1990. The goal—to achieve 1990 quantities of GHG emissions by 2020—will need to be accomplished despite 30 years of population and economic growth beyond 1990. For this reason, land uses need to be GHG "efficient" to attain AB 32 goals while accommodating population and job growth.

The City has elected to use a threshold of significance for GHG emissions that is related to the statewide GHG emissions reduction needed to achieve the AB 32 emissions mandate in 2020. When the 2008 Scoping Plan was published, ARB staff used the best available information at that time to estimate California's 2020 GHG emissions inventory. The 2020 emissions baseline used in the 2008 Scoping Plan was 596 MMT CO_2e.[1] The AB 32 emissions limit is 427 MMT CO_2e. The difference between the 2020 statewide inventory estimate and the AB 32 limit is approximately 28.4%. Based on this, the City has developed the following numeric threshold:

- The project would have a cumulatively considerable contribution to climate change impacts if it would result in a net increase of construction and operational greenhouse gas emissions, either directly or indirectly, and if statewide GHG reduction measures and project mitigation together would achieve less than a 28.4% total reduction compared to unmitigated emissions.

This threshold was chosen in spite of the fact that the Scoping Plan attributed only 8% of the 2020 Business As Usual emissions inventory to the commercial and residential sector, and allocated only relatively minimal emission reductions to the land use sector (ARB 2008). The only measure particularly aimed at the land use sector – regional transportation-related GHG targets – sets a 5 MMT CO_2e goal, which represents less than 3% of the 169 MMT CO_2e necessary reductions under AB 32 that were estimated by ARB in 2008 (ARB 2008). As part of ARB's July 2011 revision to projected Business As Usual 2020 emissions, ARB noted that this 5.0 MMT CO_2e reduction was a placeholder in the 2008 Scoping Plan for what could be achieved through regional transportation-related GHG targets, and that a 3.0 MMT CO_2e reduction is the aggregate from the regional passenger vehicle GHG reduction targets established for the 18 Metropolitan Planning Organizations approved in 2010 (ARB 2011, page 3). By using a significance threshold of 28.4%, the project is assuming a disproportionately high percentage of GHG reductions in relation to the targets assigned by ARB to the land use sector. Therefore, the City believes that the use of this threshold for determining whether the project will result in a cumulatively considerable contribution to the significant cumulative impact of global climate change is conservative. A project that does not meet this percentage reduction may well not have a significant impact under CEQA. However, in light of the absence of an adopted significance threshold applicable to projects located in the City and the legal and scientific uncertainty regarding the impact of GHG emissions from land use projects, the City is using this significance threshold for this project at this time. The use of the significance threshold in this EIR does not establish a Citywide significance threshold for analysis of GHGs for all land use or other types of projects.

The City has elected to compare the project, as if it were built out according to 2005 regulations (when AB 32 was being developed) to the project, as if built out according to regulations as they would apply in 2020 and taking into account project mitigation and design features that reduce GHG emissions. If the difference between these two totals is less than 28.4 percent, the project would have a cumulatively considerable contribution to the significant cumulative impact of global climate change. This numeric threshold would allow the City to determine

[1] ARB has since revised the original 2020 "business as usual" statewide GHG emissions estimate. The revisions take into account the economic recession and the availability of updated information from development of measure-specific regulations. The 2020 estimate may continue to change to reflect economic conditions and the continued rollout of AB 32 related regulations. For more information, please refer to ARB's Website: http://www.arb.ca.gov/cc/scopingplan/status_of_scoping_plan_measures.pdf.

whether the project at hand as achieved its "fair share" of emissions reductions needed to reach the AB 32 mandate statewide. Although under AB 32, different levels of emissions reduction will be achieved from different emissions sectors, the City's threshold allows an overall comparison of a project's emissions reductions with the statewide percentage emissions reductions from all sectors that would have been required according to the 2008 Scoping Plan to achieve the AB 32 emissions mandate.

This approach focuses on a 2020 timeline, consistent with the legislative mandate embodied in AB 32. Although construction and operation of the SPA will continue beyond 2020, calculation of a post-2020 GHG performance metric is too speculative at the present time. One of the primary challenges to establishing a reasonable threshold and determining impacts (and mitigation) relates to enactment of AB 32 and other GHG emission-reduction legislation. As previously described, much of this legislation requires ARB and other agencies to establish policies and regulations that relate to energy efficiency, carbon levels in fuels, stationary source emissions, and regional transportation planning (i.e., SB 375). Many of these individual regulations are in the development process and may be a few to several years away from implementation. The project, however, would also be in development for two decades, and during its lifetime would be subject to these as-yet-undeveloped policies and regulations. There is not a comprehensive regulatory or legislative framework for addressing GHG emissions beyond 2020. Consequently, local governmental agencies are caught in a transitional period during which they must decide on some GHG emission reduction target for land uses below business as usual, but it is unknown whether they will hit the target or need to impose additional GHG reduction measures in the future. This challenge is discussed in more detail in the "Impact Analysis" section below. Currently, GHG emissions are being reduced by policies, rules, and programs outlined in the Scoping Plan to meet the goal of 1990 GHG emission levels by 2020; there are no such policies, rules, and programs in place to address post-2020 GHG emissions. As the regulatory environment develops, and a post-2020 performance standard (or other GHG threshold of significance) is developed at the Federal, state, and/or local air district level, individual increments of development would be required to comply with this and all other future applicable CEQA requirements.

Although, for the purposes of a significance determination, a 2020 timeline is used, the City also reports GHG emissions estimates for the anticipated buildout year (2032).

Analysis Methodology

The methodology used in this EIR/EIS to analyze the project's contribution to global climate change includes a calculation of GHG emissions and a discussion about the context in which they can be evaluated and mitigated. The project's GHG emissions have been calculated for informational and comparative purposes, as SMAQMD has not adopted a quantifiable threshold for evaluating significance of project-level GHG emissions on the impact of global climate change.

At the time of writing this EIR/EIS, neither ARB nor SMAQMD has formally adopted a recommended methodology for estimating GHG emissions associated with development projects. The Bay Area Air Quality Management District (BAAQMD) has recommended use of the BAAQMD Greenhouse Gas Model (BGM) (Rimpo and Associates 2010), which was developed for use with URBEMIS (Rimpo and Associates 2008). BGM estimates operational GHG emissions associated with development of a project (apart from and including those already calculated in URBEMIS), including transportation, electricity, natural gas, solid waste, water and wastewater, and area-source (hearth and landscaping) emissions. With additional user input, BGM will provide estimates of GHG emissions from agriculture, off-road equipment, and refrigerants. URBEMIS and BGM also calculate GHG reductions associated with various mitigation measures.

Though SMAQMD has not developed a numeric threshold of significance for determining cumulative significance, its *Guide to Air Quality Assessment in Sacramento County* (2009) does recommend that lead agencies estimate GHG emissions associated with short-term, project-related construction activities, as well as the long-term, operational emissions associated with a project, including direct mobile- and area-source GHG emissions and indirect emissions associated with the project's consumption of electricity and water (SMAQMD 2009a:6-6).

GHG emissions associated with construction and operation of the Proposed Project and the other four action alternatives were modeled using URBEMIS 2007 version 9.2.4 (Rimpo and Associates 2008) and BGM version 1.1.9 beta (Rimpo and Associates 2010). Land use and trip generation data for the Proposed Project and the other four action alternatives were obtained from the project applicants and traffic consultant (Fehr & Peers 2010).

Total construction emissions for the 20-year buildout period (2012 to 2032) associated with implementation of the Proposed Project and the other four action alternatives were estimated using the URBEMIS 2007 Version 9.2.4 computer program (Rimpo and Associates 2008). URBEMIS is designed to model construction emissions for land use development projects based on building size, land use and type, and disturbed acreage and allows for the input of project-specific information.

Construction-generated GHG emissions were modeled based on general information provided in Chapter 2, "Alternatives," and default SMAQMD-recommended settings and parameters attributable to the proposed land use types and site location. Modeling was conducted using the same assumptions for estimating construction-generated emissions of criteria air pollutants and precursors, which are listed in the discussion under Impact 3.2-1 of Section 3.2, "Air Quality."

Development of the SPA would occur over a large area (approximately 1,250 acres, about 1,017 acres of which would be graded), and for modeling purposes, is assumed to occur in three phases over the course of 20 years (6.67 years per phase) (see Exhibit 2-22 in Chapter 2, "Alternatives"). Large portions of the SPA, the largest being 570 acres or 56% of the total graded area, could undergo construction during a single phase, which would require substantial amounts of earthwork and grading.

For purposes of this analysis, construction of the site was assumed to commence in 2012 and last until approximately 2032. Given that exhaust emission rates of the construction equipment fleet in the state are expected to decrease over time due to state and SMAQMD-led efforts, maximum daily construction emissions were estimated using the earliest possible calendar date when construction would begin (i.e., 2012) in order to generate conservative estimates. In the event that construction begins later, the emissions estimates would be lower than presented here. It is anticipated that in later years, advancements in engine technology, retrofits, and turnover in the equipment fleet would result in increased fuel efficiency, potentially more alternatively-fueled equipment, and lower levels of GHG emissions. While the URBEMIS model can account for potential mitigations, this analysis calculated likely reductions using tools other than URBEMIS. As described in more detail later, for the purposes of estimating the effect of project design features and mitigation, CAPCOA's 2010 document, *Quantifying Greenhouse Gas Mitigation Measures*, was used. Also, the URBEMIS model does not account for reductions in CO_2 emission rates that would affect future construction activity due to the regulatory environment that is expected to evolve under AB 32. For instance, ARB's Scoping Plan identifies the need to expand efficiency strategies and low carbon fuels for heavy-duty and off-road vehicles (ARB 2008).

BGM was developed using vehicle fleet characteristics, energy consumption, waste generation, water use, and wastewater generation data specific to the San Francisco Bay Area. For the purposes of estimating GHG emissions from the Proposed Project and the other four action alternatives, Sacramento area parameters were used to overwrite the BGM defaults. EMFAC 2007 (ARB 2006) and the Pavley I + LCFS Postprocessor Ver1.0 (ARB 2010b) were also run for the Proposed Project and the other four action alternatives to adjust BGM mobile source emissions and reductions associated with the Pavley (AB 1493) and the LCFS (AB 32/Scoping Plan) regulations. All modeling assumptions and output are contained in Appendix N.

The effectiveness of project design features and mitigation was estimated along with the effect of relevant statewide GHG reduction measures. The effect of statewide measures was calculated independent of the effectiveness of project design features and mitigation, for disclosure purposes. The total effectiveness of adopted statewide measures and project design features and mitigation was summarized against a target of a 28.4% reduction compared to the "No Action Taken" scenario. The No Action Taken scenario represents the project built out and cumulative construction emissions for the life of the project, assuming 2005 regulatory requirements. One particular focus of analysis was of measures included in the SunCreek Air Quality Mitigation Plan (AQMP). Quantification of the benefits of the AQMP measures mostly relies on CAPCOA's 2010 document, *Quantifying Greenhouse Gas Mitigation Measures*.

IMPACT ANALYSIS

Impacts that would occur under each alternative development scenario are identified as follows: NP (No Project), NCP (No USACE permit), PP (Proposed Project), BIM (Biological Impact Minimization), CS (Conceptual Strategy), and ID (Increased Development). The impacts for each alternative are compared relative to the PP at the end of each impact conclusion (i.e., similar, greater, lesser).

IMPACT 3.4-1	**Generation of Short-Term, Construction-Related and Long-Term Operational GHG Emissions.** *Project-related construction activities associated with development of the project would result in increased generation of temporary and short-term construction-related GHG emissions. Operation of the project over the long term would result in increased generation of GHGs, which would contribute considerably to cumulative GHG emissions.*

NP

Because the project would not be implemented, **no direct** or **indirect** project-related impacts would occur related to construction-generated GHG emissions. ***[Lesser]***

Mitigation Measure: No mitigation measures are required.

NCP, PP

Similar types of emission-generating activities would occur during construction of all five action alternatives. Construction-generated GHG emissions associated with each alternative would differ in the total number of residential units, commercial square footage, office square footage, and school square footage to be developed.

GHG emissions would be generated throughout the operational life of action alternatives, also. Operational emissions may be both direct and indirect emissions, and would be generated by area, mobile, and stationary sources. Direct area-source emissions would be associated with activities, such as combustion of natural gas for hearth furnaces and maintenance of landscaping and grounds. Natural gas combustion for space and water heating is also a direct area source of GHG emissions, but is considered separately from other area-sources. Direct mobile-source emissions of GHGs would include project-generated vehicle trips for residents, employees, and visitors. Lastly, solid waste and wastewater generated by activities within the SPA would result in direct, off-site emissions of GHGs.

A summary of the GHG emissions generated during buildout of all action alternatives is presented in Table 3.4-1. Refer to Appendix N for a detailed summary of the modeling assumptions, inputs, and outputs. Construction-related emissions are described in detail first, followed by operational emissions.

Construction

Heavy-duty off-road equipment, materials transport, and worker commutes during construction of the No USACE Permit and Proposed Project Alternatives would result in exhaust emissions of GHGs. Because specific data about the individual construction projects within each phase (e.g., construction equipment types and number requirements) were not available at the time of this analysis, URBEMIS defaults were used (see Appendix N for the detailed construction equipment list and schedule).

GHG emissions generated by construction would be primarily in the form of CO_2. Although emissions of other GHGs, such as CH_4 and N_2O, are important with respect to global climate change, the emission levels of these other GHGs from on- and off-road vehicles used during construction are relatively small compared with CO_2 emissions, even when factoring in the relatively larger global warming potential of CH_4 and N_2O.

As shown in Table 3.4-1, estimated GHG emissions from construction during the 20-year buildout horizon of the No USACE Permit Alternative would be approximately 11,610 MT CO_2. As shown in Table 3.4-1, estimated GHG emissions from construction during the 20-year buildout of the Proposed Project Alternative would be approximately 17,010 MT CO_2. These values account for exhaust emissions of GHGs that would be generated by heavy-duty equipment, haul trucks, and vehicle trips.

Additional GHG emissions would also be "embodied" in the materials selected for construction, and, depending on where the materials were manufactured, long-distance transport emissions associated with delivery of materials to the SPA may be substantial. The level of embodied GHG emissions within building materials can vary substantially according to which materials are selected. This is particularly the case for construction of buildings and infrastructure that involve high quantities of cement or steel (EPA 2009:4).[2]

ARB's Scoping Plan does not directly discuss GHG emissions generated by construction activity. However, it does recommend measures for improving the efficiency of medium- and heavy-duty on-road vehicles (1.4 MT CO_2e) and expanded efficiency strategies for off-road vehicles (e.g., forklifts, bulldozers). For this reason, levels of GHG emissions associated with construction activity are expected to decrease over time as new regulations are developed under the mandate of AB 32.

Operational

Indirect emissions sources include stationary-source emissions from electricity generation at off-site utility providers that would supply power to the SPA. The GHGs associated with the consumption of electricity in the SPA are indirect emissions. Consumption of water within the SPA would also result in indirect GHG emissions because of the electricity consumption associated with the off-site conveyance, distribution, and treatment of that water.

GHG emissions generated by operation of the proposed land uses would be primarily in the form of CO_2, except those generated by the decomposing organic fraction of solid waste, as well as wastewater treatment, which are primarily CH_4.

Emissions of GHGs are influenced by the location of various land uses (i.e., the layout of the Specific Plan influences trip lengths and travel modes) and the design of the land uses (the degree to which the land uses are designed to accommodate non-automobile travel, maximize energy efficiency, including building energy efficiency, water use (including landscaping), waste and wastewater generation, etc.). Similarly, the layout and design of projects constructed within the SPA will influence the relative level of GHG emissions.

At the time of writing this EIR/EIS, emission factors and calculation methods for GHGs from development projects have not been formally adopted for use by the state or SMAQMD. Direct and indirect operational CO_2e

[2] Such materials would be present and would be intended to meet general market demand, regardless of whether the project moves forward. To clarify whether life cycle emissions should be a part of the CEQA analyses, 2010 amendments to the State CEQA Guidelines removed the term "life cycle," since "the term could refer to emissions beyond those that could be considered indirect effects of a project as that term is defined in Section 15358 of the State CEQA Guidelines." Life cycle emissions, therefore, are not included in the totals presented here for any of the action alternatives. For more information, please refer to CNRA 2009.

emissions were estimated using URBEMIS 2007 version 9.2.4 (Rimpo and Associates 2008) and BGM version 1.1.9 beta (Rimpo and Associates 2010), as described previously.

A summary of the operational GHG emissions were estimated for full buildout of the Proposed Project and the other four action alternatives in the year 2032 and are presented in Table 3.4-1. The annual operational emissions levels under each alternative were estimated using the best available methodologies and emission factors. However, for some operational GHG emission sources, GHG emission rates and activity levels for future years are not yet developed, in part, because regulations continue to evolve under the mandate of AB 32. The URBEMIS and BGM models do not yet account for the impact reductions of the future regulatory environment and future technological improvements that will result in GHG efficiencies. Thus, this analysis uses the emissions estimates modeled for full buildout as a conservative proxy for evaluating GHG emissions associated with operation of the Proposed Project and action alternatives.

As shown in Table 3.4-1, estimated annual GHG emissions associated with operation of the land uses proposed under the No USACE Permit Alternative would total approximately 72,573, MT CO_2e/year. As shown in Table 3.4-1, estimated annual GHG emissions associated with operation of the land uses proposed under the Proposed Project would total approximately 109,627 MT CO_2e/year.

The annual CO_2e values in Table 3.4-1 for each alternative are higher than what would likely occur. Mobile-source emissions, which are estimated to be 56-62% of the total operational emissions (depending on which action alternative is selected), take into account the Pavley and LCFS GHG reductions (see "Analysis Methodology" section above), but are also based on the VMT and trip rates generated by the traffic study, which are somewhat conservative. The estimate of indirect GHG emissions related to electricity consumption, the second largest category of operational GHG emissions shown in Table 3.4-1, does not account for reductions that will result from future regulatory changes under AB 32, such as the alternative-energy mandate of SB 107, which would be implemented before full buildout of the Proposed Project and action alternatives. Additionally, SB 1368 will require more stringent emissions performance standards for new power plants – both in-state and out-of-state – that will supply electricity to California consumers. Lastly, rates of energy consumption will be reduced with implementation of the 2010 California Green Building Standards Code (CalGreen), which was drafted, in part, to improve energy efficiency and conserve water.

Further reductions are also expected from other regulatory measures that will be developed under the mandate of AB 32, as identified and recommended in ARB's Scoping Plan (ARB 2008). In general, the Scoping Plan focuses on achieving the state's GHG reduction goals with regulations that improve the efficiency of motor vehicles and the production (and consumption) of electricity. Even without project-specific mitigation, the rate of GHG emissions from the proposed development are projected to decrease in subsequent years as the regulatory environment progresses under AB 32. Additionally, new technology improvements may become available or the feasibility of existing technologies may improve.

Based on the GHG emissions estimates, without the application of statewide reduction measures and project design features or mitigation to reduce total emissions by at least 28.4%, implementation of any of the action alternatives would result in a cumulatively considerable contribution to a **significant** cumulative impact related to long-term operational generation of GHGs. ***[Lesser]***

Mitigation Measure: Implement Mitigation Measure 3.2-1a.

Mitigation Measure 3.4-1a: Implement Measures to Reduce Construction-Generated GHG Emissions.

Prior to releasing each request for bid to contractors for the construction of each development phase, project applicants shall obtain the most current list of construction-related GHG reduction measures that are published by SMAQMD. All feasible measures from this list shall be implemented in the project's construction contract with the selected primary contractor. Project applicants may submit to City and SMAQMD a report that substantiates why specific measures are considered infeasible for construction of

Table 3.4-1
Summary of Modeled Greenhouse Gas Emissions (CO_2e) from Project Construction and Operations for the Action Alternatives Under Consideration

Source	CO_2e Emissions by Alternative[1]				
	NCP	PP	BIM	CS	ID
Cumulative Construction Emissions over Buildout Period (2012–2032) (metric tons) [2]	11,610	17,010	13,035	13,867	18,597
Approximate Annual Amortized Construction Emissions (assuming 40-year project life) (MT CO_2e/yr)	290	425	326	347	465
Operational Emissions at Full Buildout (Year 2032) (metric tons/year)					
Transportation[3]	40,890	67,270	41,945	53,398	64,290
Area Source[3]	29	33	32	33	60
Electricity[4]	17,167	23,883	15,450	17,952	21,690
Natural Gas[5]	9,741	10,102	8,931	9,770	11,738
Water and Wastewater[6]	1,075	1,461	1,323	1,403	1,674
Solid Waste	3,671	6,878	3,273	3,910	4,697
Total Operational Emissions[7]	**72,573**	**109,627**	**70,953**	**86,465**	**104,149**
Percentage GHG Reduction from Statewide Measures	**23.3%**	**23.5%**	**23.1%**	**23.2%**	**23.2%**
Percentage GHG Reduction from Project Design Features	**5.2%**	**5.6%**	**5.2%**	**5.1%**	**5.1%**
Total Percentage GHG Reduction from Statewide Measures + Project Design Features[8]	**28.4%**	**29.1%**	**28.3%**	**28.3%**	**28.3%**
Total Annual Operational Emissions + Construction Emissions (construction amortized over 40 years)[7]	**72,863**	**110,052**	**71,279**	**86,812**	**104,614**

Notes: CO_2e = carbon dioxide equivalent; NCP (No USACE permit), PP (Proposed Project), BIM (Biological Impact Minimization), CS (Conceptual Strategy), and ID (Increased Development); GHG = greenhouse gas; SP = Service Population; AB = Assembly Bill; ARB = Air Resources Board; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; VMT = vehicle miles traveled; CCAR = California Climate Action Registry; CEC = California Energy Commission

1 The values presented do not include the full life cycle of GHG emissions that would occur over the production/transport of materials used during the construction of each build alternative or used during the operational life of the project, construction waste that would be generated over the life of the project, and the end of life for the materials and processes that would occur as an indirect result of the project. Estimating the lifecycle GHG emissions associated with these processes would be too speculative for meaningful consideration and would require analysis beyond the current state of the art in impact assessment, and may lead to a false or misleading level of precision in reporting operational GHG emissions. Note that this table does not include the No Project Alternative, because information regarding development under this alternative was not available at the time of writing this EIR/EIS.

2 Construction emissions were modeled with the URBEMIS 2007 computer model using the same assumptions and input parameters to estimate criteria air pollutant emissions in Section 3.2, "Air Quality – Land." The URBEMIS 2007 model does not account for CO_2 emissions associated with the production and long-range transportation of concrete or other building materials used in project construction. It also does not estimate GHG emissions other than CO_2, though the levels of these pollutants (i.e., CH_4 and N_2O) are expected to be nominal in comparison to the estimated CO_2 levels, even considering their respective global warming potentials. Estimated values represent the levels of construction-generated GHG emissions that would be generated during the entire 20-year construction period. See Appendix N for detailed calculations.

3 Direct operational area- and mobile-source emissions were modeled using the URBEMIS 2007 and BGM computer models, based on VMT and the number of trips obtained from the traffic analysis, as well as the same assumptions and input parameters used to estimate criteria air pollutant emissions in Section 3.2, "Air Quality." EMFAC 2007 and the Pavley I + LCFS Post-Processor were used to adjust mobile source CO_2 emissions reductions applied by BGM to account for the difference in vehicle fleets between Sacramento County and the Bay Area. See Appendix N for detailed calculations.

4 Indirect operational CO_2e emissions associated with electricity consumption were estimated using BGM with commercial and residential parameters from SMUD and EIA, to adjust for Sacramento-specific conditions. See Appendix N for detailed calculations.

5 Direct operational CO_2e emissions associated with gas consumption were estimated using BGM with commercial and residential parameters from PG&E and EIA, to adjust for Sacramento-specific conditions. See Appendix N for detailed calculations.

6 Electricity consumption associated with the consumption of water was estimated using BGM and projected demand factors for Sacramento County. See Appendix N for detailed calculations.

7 Forty years is the presumed lifetime of the project for calculating cumulative GHG emissions, per SMAQMD (SMAQMD 2009:6-8).

8 Emission reductions from applicable statewide measures, project design features, and mitigation were estimated for each alternative. Details are in Appendix N.

Source: Modeling performed by AECOM in 2010 and 2012

that particular development phase and/or at that point in time. The report, including the substantiation for not implementing particular GHG reduction measures, shall be approved by the City in consultation with SMAQMD prior to the release of a request for bid by project applicants for seeking a primary contractor. By requiring that the list of feasible measures be established prior to the selection of a primary contractor, this measure requires that the ability of a contractor to effectively implement the selected GHG reduction measures be inherent to the selection process.

SMAQMD's recommended measures for reducing construction-related GHG emissions at the time of writing this EIR/EIS are listed below (SMAQMD 2010). Those that are duplicative of Mitigation Measure 3.2-1a were removed:

- Improve fuel efficiency from construction equipment:
  - Train equipment operators in proper use of equipment.
  - Use the proper size of equipment for the job.
  - Use equipment with new technologies (repowered engines, electric drive trains).
- Perform on-site material hauling with trucks equipped with on-road engines (if determined to be less emissive than the off-road engines).
- Use alternative fuels for generators at construction sites such as propane or solar, or use electrical power.
- Use an ARB approved low carbon fuel for construction equipment. (NOx emissions from the use of low carbon fuel must be reviewed and increases mitigated.)
- Encourage and provide carpools, shuttle vans, transit passes and/or secure bicycle parking for construction worker commutes.
- Reduce electricity use in the construction office by using compact fluorescent bulbs, powering off computers every day, and replacing heating and cooling units with more efficient ones.
- Recycle or salvage non-hazardous construction and demolition debris (goal of at least 75% by weight).
- Use locally sourced or recycled materials for construction materials (goal of at least 20% based on costs for building materials, and based on volume for roadway, parking lot, sidewalk and curb materials). Wood products utilized should be certified through a sustainable forestry program.
- Minimize the amount of concrete for paved surfaces or utilize a low carbon concrete option.
- Produce concrete on-site if determined to be less emissive than transporting ready mix.
- Use SmartWay certified trucks for deliveries and equipment transport.
- Develop a plan to efficiently use water for adequate dust control.

Implementation: Project applicants during any particular discretionary development application.

Timing: Before approval of final maps and building permits for all project phases and implementation throughout project construction.

Enforcement: City of Rancho Cordova Community Development Department in consultation with SMAQMD.

Mitigation Measure 3.4-1b: Implement Measures to Reduce Long-Term, Operational GHG Emissions

Project applicants shall submit to the City a list of feasible energy efficient design standards to be considered in the project-specific design review. These energy conservation measures, which will be incorporated into the design, construction, and operational aspects of proposed projects, would result in a reduction in overall project energy consumption and GHGs. The project-specific design review shall further identify potentially feasible GHG reduction measures that reflect the current state of the regulatory environment and available incentives. The City shall review and ensure inclusion of the design features in the project before the applicants can receive the City's discretionary approval for projects developed within the SPA. In determining what measures should appropriately be imposed by the City under the circumstances, the City shall consider the following factors:

- the extent to which rates of GHG emissions generated by motor vehicles traveling to, from, and within the project site are projected to decrease over time as a result of regulations, policies, and/or plans that have already been adopted or may be adopted in the future by ARB or other public agency pursuant to AB 32, or by EPA;
- the extent to which mobile-source GHG emissions, which at the time of writing this EIR/EIS comprise a substantial portion of the state's GHG inventory, can also be reduced through design measures that result in trip reductions and reductions in trip length;
- the extent to which GHG emissions emitted by the mix of power generation operated by SMUD, the electrical utility that will serve the project site, are projected to decrease pursuant to the Renewables Portfolio Standard, as well as any future regulations, policies, and/or plans adopted by the federal and state governments that reduce GHG emissions from power generation;
- the extent to which any stationary sources of GHG emissions that would be operated on a proposed land use (e.g., industrial) are already subject to regulations, policies, and/or plans that reduce GHG emissions, particularly any future regulations that will be developed as part of ARB's implementation of AB 32, or other pertinent regulations on stationary sources that have the indirect effect of reducing GHG emissions;
- the extent to which other mitigation measures imposed on the project to reduce other air pollutant emissions may also reduce GHG emissions;
- the extent to which replacement of CCR Title 24 with the California Green Building Standards Code or other similar requirements will result in new buildings being more efficient and thus, more GHG-energy efficient; and
- whether total costs of proposed mitigation for GHG emissions together with other mitigation measures required for the proposed development are so great that a reasonably prudent property owner would not proceed with the project in the face of such costs.

GHG emission reduction strategies and their respective feasibility are likely to evolve over time. Project applicants shall consider and implement, as feasible, the following non-exclusive and non-exhaustive list of measures, listed below. These measures are derived from multiple sources, including the SMAQMD's Draft GHG Measures (SMAQMD 2009); *Mitigation Measure Summary* in Appendix B of the California Air Pollution Control Officer's Association (CAPCOA) white paper, *CEQA & Climate Change* (CAPCOA 2009a); CAPCOA's *Model Policies for Greenhouse Gases in General Plans* (CAPCOA 2009b); the California Attorney General's Office publication entitled *The California Environmental*

Quality Act: *Addressing Global Warming Impacts at the Local Agency Level* (California Attorney General's Office 2008); and the BAAQMD's CEQA Guidelines (BAAQMD 2010:4-14–4-19).

Projects will be required to implement, to the maximum extent feasible, mitigation measures that, combined with the application of applicable statewide reduction measures, would be sufficient to achieve at least a 28.4% reduction in GHG emissions compared to the unmitigated project as if it was constructed in compliance with the 2005 (pre-AB 32) regulatory environment.

Energy Efficiency

- Include clean alternative energy features to promote energy self-sufficiency (e.g., photovoltaic cells, solar thermal electricity systems, small wind turbines).
- Install solar water heaters.
- Buildings will be designed to exceed Title 24 building envelope energy efficiency standards by 20%.
- Require smart meters and programmable thermostats.
- Perform HVAC duct sealing and conduct periodic inspection.
- Site buildings to take advantage of shade and prevailing winds and design landscaping and sun screens to reduce energy use. Plant shade trees within 40 feet of the south sides or within 60 feet of the west sides of properties.
- Install efficient lighting in all buildings (including residential). Also install lighting control systems, where practical. Maximize daylight as an integral part of lighting systems in all buildings.
- Install cool roof materials (albedo ≥ 30).
- Install light-colored "cool" pavements, and strategically located shade trees along all bicycle and pedestrian routes.

Water Conservation and Efficiency

- With the exception of ornamental shade trees, use water-efficient landscapes with native, drought-resistant species in all public area and commercial landscaping. Use water-efficient turf in parks and other turf-dependent spaces.
- Install the infrastructure and necessary treatment to use reclaimed water for landscape irrigation and/or washing cars, including installation of rainwater collection systems.
- Install water-efficient irrigation systems and devices, such as soil moisture-based irrigation controls.
- Design buildings and lots to be water-efficient. Only install water-efficient fixtures and appliances.
- Restrict watering methods (e.g., prohibit systems that apply water to nonvegetated surfaces) and control runoff. Prohibit businesses from using pressure washers for cleaning driveways, parking lots, sidewalks, and street surfaces. These restrictions should be included in the Covenants, Conditions, and Restrictions of the community.
- Provide education about water conservation and available programs and incentives.

- To reduce stormwater runoff, which typically bogs down wastewater treatment systems and increases their energy consumption, construct driveways to single-family detached residences and parking lots and driveways of multi-family residential uses with pervious surfaces. Possible designs include Hollywood drives (two concrete strips with vegetation or aggregate in between) and/or the use of porous concrete, porous asphalt, turf blocks, or pervious pavers.

- Comply with any applicable water conservation ordinances.

Solid Waste Measures

- Reuse and recycle construction and demolition waste (including, but not limited to, soil, vegetation, concrete, lumber, metal, and cardboard).

- Provide interior and exterior storage areas for recyclables, food waste and green waste at all buildings; create food waste and greenwaste curbside pickup.

- Provide adequate recycling containers in public areas, including parks, school grounds, golf courses, and pedestrian zones in areas of mixed-use development.

- Provide education and publicity about reducing waste and available recycling services.

Transportation and Motor Vehicles

- Promote ride-sharing programs and employment centers (e.g., by designating a certain percentage of parking spaces for ride-sharing vehicles, designating adequate passenger loading and unloading zones and waiting areas for ride-share vehicles, and providing a Web site or message board for coordinating ride-sharing).

- Provide the necessary facilities and infrastructure in all land use types to encourage the use of low- or zero-emission vehicles (e.g., electric vehicle charging facilities and conveniently located alternative fueling stations).

- Provide the necessary facilities and maintenance for free tire inflation.

- Provide transit stops with safe and convenient bicycle/pedestrian access. Provide essential transit stop improvements (i.e., shelters, route information, benches, and lighting) in anticipation of future transit service.

- Daily parking charges for commercial uses (employee parking and retail customers) and free transit passes for residential/commercial uses (commuters and shoppers).

- Employer provides employees with a choice of forgoing subsidized parking for a cash payment equivalent to the cost of the parking space to the employer.

- Provide the minimum amount of parking required.

- At industrial and commercial land uses, all forklifts, “yard trucks,” or vehicles that are predominately used on-site at non-residential land uses shall be electric-powered or powered by biofuels (such as biodiesel [B100]) that are produced from waste products, or shall use other technologies that do not rely on direct fossil fuel consumption.

- Complete streets to encourage bicycle and pedestrian traffic:

- Bike lanes and pedestrian sidewalks on both sides of streets;
- Reduce or eliminate physical barriers between residential and non-residential uses that impede bicycle or pedestrian circulation; and
- Traffic calming features such as traffic circles.

- Non-residential projects provide plentiful short-term and long-term bicycle parking facilities to meet peak-season maximum demand.
- Non-residential projects provide "end-of-trip" facilities, including showers, lockers, and changing space.
- Long-term bicycle parking is provided at apartment complexes or condominiums without garages.

In consultation with SMAQMD, a 28.4% reduction will be achieved through implementation of the above-mentioned reduction measures within the context of projects proposed under the Specific Plan, as deemed feasible by the City of Rancho Cordova. This mitigation, in combination with existing and future regulatory measures developed under AB 32, would reduce GHG emissions associated with the operation of development within the SPA under the selected action alternative. The feasibility of potential GHG reduction measures shall be evaluated at the time that projects within the SPA are proposed in order to allow for ongoing innovations in GHG reduction technologies, as well as incentives created in the regulatory environment.

Implementation: The project applicants for any particular discretionary development application.

Timing: Before approval of final maps and/or building permits for all project phases requiring discretionary approval.

Enforcement: City of Rancho Cordova Community Development Department in consultation with SMAQMD.

BIM, CS, ID

Construction

The types of emissions-generating construction activities that would occur under the Biological Impact Minimization, Conceptual Strategy, and Increased Development Alternatives would be similar to those that would take place under the other action alternatives. Construction-generated GHG emissions were modeled in URBEMIS and are presented in Table 3.4-1. Refer to Appendix N for a detailed summary of the URBEMIS modeling assumptions, inputs, and outputs.

GHG emissions from construction during the 20-year buildout of the Biological Impact Minimization Alternative would be approximately 13,035 MT CO_2, which is less than estimated for the Proposed Project Alternative. GHG emissions from construction during the 20-year buildout of the Conceptual Strategy Alternative would be approximately 13,867 MT CO_2, which is less than estimated for the Proposed Project Alternative. As shown in Table 3.4-1, estimated GHG emissions from construction during the 20-year buildout of the Increased Development Alternative would be approximately 18,597 MT CO_2, which is more than estimated for the Proposed Project Alternative. These values account for exhaust emissions of GHGs that would be generated by heavy-duty equipment, haul trucks, and vehicle trips. A new regime of regulations is expected to come into place under AB 32 and existing regulatory efforts will help reduce GHG emissions generated by construction activity throughout the state.

Operation

As shown in Table 3.4-1, estimated annual GHG emissions associated with operation of the land uses proposed under the Biological Impact Minimization, Conceptual Strategy, and Increased Development Alternatives would total approximately 70,953 and 86,465, and 104,149 MT CO_2e/year, respectively.

The annual CO_2e emissions in Table 3.4-1 are representative of each alternative's GHG emissions, and are higher than what would likely occur. Mobile-source emissions, which are estimated to be 56–62% of the total operational emissions (depending on which action alternative is selected), take into account the Pavley and LCFS GHG reductions (see "Analysis Methodology" section above), but are also based on the VMT and trip rates generated by the traffic study, which are somewhat conservative. The estimate of indirect GHG emissions related to electricity consumption, the second largest category of operational GHG emissions shown in Table 3.4-1, does not account for reductions that will result from future regulatory changes under AB 32, such as the alternative-energy mandate of SB 107, which would be fully implemented before full buildout of the Proposed Project and the other four action alternatives. Additionally, SB 1368 will require more stringent emissions performance standards for new power plants – both in-state and out-of-state – that will supply electricity to California consumers. Lastly, rates of energy consumption will be further reduced with implementation of CalGreen, which was drafted, in part, to improve energy efficiency and conserve water and will require increasing levels energy efficiency in comparison to Title 24 building standards.

Further reductions are also expected from other regulatory measures that will be developed under the mandate of AB 32, as identified and recommended in ARB's Scoping Plan (ARB 2008). In general, the Scoping Plan focuses on achieving the state's GHG reduction goals with regulations that improve the efficiency of motor vehicles and the production (and consumption) of electricity. Even without project-specific mitigation, the rate of GHG emissions from development under the Proposed Project and the other four action alternatives are projected to decrease in subsequent years as the regulatory environment progresses under AB 32. Additionally, new technology improvements may become available or the feasibility of existing technologies may improve.

Based on the GHG emissions estimates, without the application of statewide reduction measures and project design features or mitigation to reduce total emissions by at least 28.4%, implementation of these alternatives would result in a cumulatively considerable contribution to a **significant** cumulative impact related to long-term operational generation of GHGs. ***[Lesser]***

Mitigation Measure: Implement Mitigation Measures 3.2-1a, 3.4-1a, and 3.4-1b.

Level of Impact with Mitigation – All Action Alternatives

In addition to the above described estimates of 2032 emissions at buildout of the project, this EIR/EIS also includes a scenario comparison for the purposes of characterizing cumulative significance. This analysis allows a comparison of the GHG reductions from statewide measures and project design features to the statewide emissions reduction needed to achieve the AB 32 emissions mandate. This analysis compares the project, as if it were built out according to 2005 regulations (when AB 32 was being developed) to the project, as if built out according to regulations as they would apply in 2020, taking into account project design features that reduce GHG emissions. Buildout of the five action alternatives under 2005 regulations would result in annual emissions ranging from approximately 82,000 to 142,000 MT CO_2e. Considering project design features and statewide measures as they would apply to a fully built out SPA in 2020, annual emissions would range from approximately 59,000 to 100,000 MT CO_2e. Please see Appendix N for additional details.

There were several steps involved in this quantified estimate of the benefits of statewide measures and project design features. This included an examination of energy and natural gas consumption, both for existing and forecast conditions. Since electricity is used to move water, a close examination of water demand was also included as a part of this work effort. Analysis of locally relevant energy, natural gas, and water demand, along with population projections allows GHG estimates for statewide measures to be applied to this project. Since the transportation sector is the most important source of GHG emission for this and most development plans and projects, an analysis of VMT by "speed bin" was important to both the estimate of GHG emissions and the quantification of statewide measures and project design features. (Speed bins are used to group VMT according to the speed at which they occur). VMT was also broken out into different types of vehicles in the fleet, such as automobiles, light-duty trucks, and other vehicle types. Based on the aforementioned information, as well as locally specific emission factors, it is possible to estimate the effectiveness of key statewide and regional GHG reduction measures. This includes Pavley vehicle emission standards, the Low Carbon Fuel Standard, SMUD's provision of cleaner energy sources and voluntary compliance with the Renewable Portfolio Standard, water use efficiency, energy efficiency (natural gas), and energy efficiency (electricity). Statewide measures would achieve annual reductions of between approximately 19,000 and 33,000 MT CO_2e, depending on the action alternative. Please see Appendix N for more details.

In addition to statewide measures, certain project design features that would also reduce GHG emissions associated with buildout of the action alternatives. While construction mitigation measures and other operational mitigation measures would also reduce GHG emissions, it is not possible at this time to develop numeric estimates for the benefits of all mitigation measures. Project design features that were specifically analyzed for their reduction potential are correlated with measures included in the SunCreek AQMP. These include: bicycle parking (AQMP Measures 1 and 6); end of trip facilities (AQMP Measures 2); pedestrian network (AQMP Measure 5); traffic calming (AQMP Measure 9); office/mixed-use density (AQMP Measure 15); residential density (AQMP Measure 18); and suburban mixed use (AQMP Measure 23). Please see Appendix M for more details on the AQMP.

The reduction measures/project design features that were quantified also correlate with mitigation measures for which quantification guidance is provided in CAPCOA's 2010 document, *Quantifying Greenhouse Gas Mitigation Measures.* This document, which provides guidance on quantification and compiles a large amount of empirical research and publications in academic journals, was used to estimate GHG reductions from project design features. While there are other measures included in the AQMP that would also reduce GHG emissions, there was not adequate or detailed enough information available as of the time of the writing of this document to provide quantified estimates of the effect of mitigation. Please refer to Table 3.4-1, which summarizes the benefits of statewide measures and project design features.

For the No USACE Permit Alternative, it is estimated that statewide measures, design features, and mitigation measures would reduce emissions by at least 28.4%. If design features and mitigation, as well as statewide measures (including LCFS, Pavley I, the Renewables Portfolio Standard, energy efficiency measures, and water use efficiency statewide measures) are considered, GHG emissions attributable to buildout of the Proposed Project would be reduced by 29.1% (see Appendix N for more details).

If design features and mitigation, as well as statewide measures (including LCFS, Pavley I, the Renewables Portfolio Standard, energy efficiency measures, and water use efficiency statewide measures) are considered, GHG emissions attributable to buildout of the Biological Impact Minimization, and Conceptual Strategy, and Increased Development Alternatives would be reduced by 28.3%, 28.3%, and 28.3% respectively (see Appendix N for more details). Total construction emissions were included also in this calculation (amortized over an anticipated 40-year project life). Because the total GHG emissions associated with project operations under the Biological Impact Minimization, and Conceptual Strategy, and Increased Development Alternatives would be considered substantial, and because they would not achieve at least a 28.4% reduction, this represents a **cumulatively considerable** incremental contribution to a **significant** cumulative impact related to long-term operational generation of GHGs. ***[Similar]***

By acknowledging that the regulatory environment will continue to progress and that new GHG reduction technologies will continue to be innovated over time, Mitigation Measures 3.4-1a and 1b require the implementation of mitigation measures that are appropriate and feasible for projects developed in the SPA at the time projects are proposed. Although Mitigation Measures 3.4-1a and 1b would require the implementation of all feasible mitigation measures, it is unknown at the time of writing this document whether the selected measures, in combination with potential GHG offsets and other GHG reductions realized from the regulatory environment that exists during buildout of the SPA, would reduce GHG emissions in a way that is consistent with the significance threshold used in this document. This is particularly true for public buildings, such as schools, that would be built within the SPA, but would not necessarily be subject to the same mitigation measures as other types of developments.

As the preceding discussion suggests, much of the difficulty in achieving GHG reductions through measures imposed by the City reflects the reality that the vast majority of GHG emissions associated with the Proposed Project and the other four action alternatives would be attributable to the combustion of fossil fuels, either in motor vehicles or in electricity-generating power plants.

Based on the Scoping Plan adopted by ARB on December 11, 2008, it is reasonable to expect that the State will make substantial strides in changing the make-up of transportation fuels and power plant fuels to achieve compliance with AB 32. Given the long period of build-out of the project, AB 32 should be effective in reducing GHG emissions from vehicles and power plants during the period of time in which the City approves the vast majority of development entitlements comprising the Proposed Project or the other four action alternatives. As regulations and policies gradually become effective in reducing GHG emissions, the task of achieving the relevant significance threshold should become potentially attainable. However, the precise level of reductions is difficult to calculate for all phases of development. In addition, CEQA Guidelines Section 15091(a)(2) provides that lead agencies may not rely upon mitigation within the responsibility of another public agency. In order to avoid adverse effects related to global climate change, GHG reduction activities are required by nations, states, public sector agencies, and private sector entities that are not within the jurisdiction or control of the City. In particular, the GHG reduction measures under AB 32 are largely controlled by the State agencies. Given the uncertainties in regulatory actions by other agencies, to be conservative, this EIR/EIS concludes that the incremental contribution of the No USACE Permit, Proposed Project, Biological Impact Minimization, Conceptual Strategy, and Increased Development Alternatives to long-term operational GHG emissions is **cumulatively considerable** and **significant and unavoidable**.

3.4.2 IMPACTS ON THE PROJECT FROM GLOBAL CLIMATE CHANGE

INTRODUCTION

This section analyzes the potential impact of global climate change on the project (e.g., effects of increased sea levels, reduced snow pack). Because the potential impacts of global warming have only recently been realized, firm data, commonly accepted thresholds for significance, and firm conclusions are not available. This section therefore draws from a range of studies that analyze global and regional patterns and trends. Given the uncertainties in climate change modeling and prediction there are few or no viable models or studies devoted specifically to the project vicinity. Therefore, in order to increase the data set of information about potential regional changes, some of the studies relied on analyze climate for the entire Central Valley, including both the Sacramento and San Joaquin Valleys.

Since there are no formally accepted methodologies, a lead agency must use its best efforts to find out and disclose all that it reasonably can about the potential adverse environmental effects of a proposed project or on a proposed project. However, the analysis cannot rely on speculation. Speculation that is based on unspecified and uncertain future effects that cannot reasonably be evaluated cannot result in verifiable analyses. Furthermore, such analysis could mislead the decision makers and the public. As indicated in the State CEQA Guidelines, “If after a thorough investigation, an agency finds that a particular impact is too speculative for evaluation, the agency should note its conclusion and terminate discussion of the impact” (State CEQA Guidelines CCR Section 15145).

The following analysis is based on available information and projections applicable to estimating the types of effects that may occur. While some effects of global climate change are reasonably foreseeable, the extent to which many of these effects would manifest themselves and the potential of other effects to occur, remain speculative. In the interests of fully informing the decision makers, many of the potential effects that are subject to a high degree of speculation are discussed in the following evaluation, despite the fact that it would be too speculative to draw a conclusion as to their significance. The discussion herein focuses on the potential effects of climate change on the project, rather than the potential of the project to contribute to global climate change.

Although there is a strong scientific consensus that global warming/global climate change is occurring and is greatly influenced by human activity, there is less certainty as to the timing, severity, and potential consequences of global climate change. Scientists have identified several ways in which global climate change could alter the physical environment in California (Kiparsky and Gleick 2005, Roos 2005, California Department of Water Resources [DWR] 2006). These include:

- increased average temperatures;
- modifications to the timing, amount, and form (rain versus snow) of precipitation;
- changes in the timing and amount of runoff;
- reduced water supply;
- deterioration of water quality; and
- elevated sea level.

The changes listed above may translate into a variety of other issues and concerns, such as:

- reduced agricultural production as a result of changing temperatures and precipitation patterns;
- changes in the composition, health, and distribution of terrestrial and aquatic ecosystems;
- reduced hydroelectric energy production caused by changes in the timing and volume of runoff; and
- reduced availability of energy because of greater demands associated with increased temperatures.

However, this evaluation of the effects of global climate change on the project does not address climate change associated with energy supply for the following reasons:

- There are many potentially wide-ranging direct and indirect effects of global climate change, such as potential reductions in hydroelectric energy production. These reductions could result from changes in the timing and volume of runoff that would cause reductions in the generation of electricity. However it is too speculative to determine that these potential changes would affect the project because they are both geographically remote and the impact on overall energy supply and markets is unknown. Also, potential changes may be addressed or corrected by other entities (e.g., energy providers increasing generation capacity to meet the increased demand that is not specifically associated with the project; greater development and use of alternative energy sources such as solar to offset capacity losses); and

- The specific measures that would be implemented to address more wide-ranging direct and indirect effects of global climate change cannot be reasonably projected at this time.

This analysis does not suggest that the project would see no effect related to energy supply. Rather, any effects would be the same at the project vicinity, as elsewhere in the county, region, state, nation, and world, and would not result in specific unique impacts in the project vicinity.

This analysis focuses on the effects of global climate change that might have a direct, reasonably foreseeable effect on physical conditions in the project vicinity. Therefore, this analysis gives greatest consideration to climate-change data with more consistency in projections of future conditions, and thus a probability for a greater likelihood of occurring within a reasonable time frame (i.e., approximately 100 years).

Because the impacts of global change would be similar within a regional or local area, this analysis assumes that regardless of whether the No Project, No USACE Permit, Proposed Project, Biological Impact Minimization, Conceptual Strategy, or Increased Development Alternatives were implemented, the impact on the project would be substantially similar.

INFORMATION SOURCES

Information on the current state of the science surrounding climate change was derived from research papers, technical memoranda, literature summaries, and studies, including the following:

- United Nations Intergovernmental Panel on Climate Change documents *Climate Change 2001: The Scientific Basis* (IPCC 2001a); *Climate Change 2001: Synthesis Report* (IPCC 2001b); and *Climate Change 2007: The Physical Basis. Summary for Policymakers* (IPCC 2007);

- *California Water Plan Update 2005* (Bulletin 160-05) (DWR 2005a) and accompanying papers *Climate Change and California Water Resources: A Survey and Summary of the Literature* (Kiparsky and Gleick 2005) and "Accounting for Climate Change" (Roos 2005);

- *Progress on Incorporating Climate Change into Planning and Management of California's Water Resources, Technical Memorandum Report* (DWR 2006); and

- published reports on aspects of climate change and associated effects (see Chapter 5, "References," of this EIR/EIS for a listing of all information sources cited in this section).

CHARACTERIZATION OF CLIMATE CHANGE IMPACTS

This section summarizes the current scientific perspective of climate change and associated effects, particularly those that could affect the project. Information is provided for each effect of climate change considered in this document, consisting of:

- increased temperature;
- precipitation volume, type, and intensity;
- runoff volume and timing;
- water supply;
- sea level rise;
- water quality changes; and
- agricultural changes.

For each climate change effect there is a discussion of:

- status of current scientific information and data about past trends;

- projected future changes and the accuracy and variability of modeling results, including identification of results presumed too speculative for conclusive analysis; and

- potential for the environmental effects of climate change to affect the Proposed Project Alternative, based both on the certainty or uncertainty of modeling results and on the physical nature of the effect.

This information is used in this section to consider and evaluate potential environmental impacts of future climate change on the project.

Background

Theories about climate change and global warming existed as early as the late 1800s. It was not until the later 1900s that understanding of the Earth's atmosphere had advanced to the point where many atmospheric and climate scientists began to accept that the Earth's climate is changing (IPCC 2001a, 2001b; DWR 2006).

In recent years, the scientific consensus has broadened to consider increasing concentrations of GHGs, attributable to anthropogenic (human) activities, as a primary cause of global climate change. The United Nations IPCC predicts that changes in the Earth's climate will continue through the 21st century and that the rate of change may increase significantly in the future because of the growing population and associated increase in human activity (IPCC 2001b, 2007). Recent studies confirm the existence of climate change, and emphasize the occurrence of impacts in the next 20–50 years (Backlund, Janetos, and Schimel 2008), but the scope and rate of change remains uncertain.

In recent years, the issue of global climate change has had an increasing role in scientific and policy debates over multiple environmental topics such as land use planning, transportation planning, energy production, habitat and species conservation, use of ocean resources, and agricultural production. Of particular concern are the existing and potential future effects of global climate change on hydrologic systems and water management (e.g., domestic water supply, agricultural water supplies, flood control, water quality). There is evidence that global climate change has already had an effect on California's hydrologic system. For example, historical data indicate a trend toward declining volumes of spring and summer runoff from the Sierra Nevada.

California water planners and managers have been among the first groups in the nation to realize the potential implications of statewide and regional climate change (rather than global-scale changes) on the reliability and safety of their systems. Research and analysis on climate risks facing California water resources began in the early 1980s, and by the end of that decade, state agencies such as the CEC had prepared the first assessments of state GHG emissions and possible impacts on a wide range of sectors. The California Water Plan (Bulletin 160) first addressed climate change in 1993 (DWR 1993). More recently, DWR and the Public Interest Energy Research program of CEC expanded and refined the analysis of climate change effects in California in the 2005 update of the California Water Plan, which explores a wide range of climate impacts and risks, including risks to water resources (Kiparsky and Gleick 2005, Roos 2005). The 2005 update also describes efforts that should be taken to quantitatively evaluate climate change effects for the next Water Plan update (DWR 2005a). DWR has also followed up on these issues with a technical memorandum report that specifically discusses progress on modeling climate change in the state, characterizes the effects of climate change, and incorporates climate change into planning and management of California's water resources (DWR 2006).

Variability in Regional Modeling of Climate Change

Much of the available trend data, modeling, and projections related to climate change are on a global scale. Climate change projections often rely on general circulation models (GCMs). These models develop large-scale scenarios of changing climate parameters, usually comparing scenarios with different concentrations of greenhouse gases in the atmosphere. This information is typically not specific enough to make accurate regional assessments. As a result, more effort has recently been put into reducing the scale and increasing the resolution of climate models through various techniques such as "downscaling" or integrating regional models into the global models (Kiparsky and Gleick 2005, Roos 2005, DWR 2006). However, the level of uncertainty related to regional climate change is generally higher than that related to global projections because these current methodologies add uncertainty.

Variability in the results of climate change modeling is largely based on which global climate model is used, what inputs are selected for the model (world population increases and greenhouse gas emissions), and how the model is downscaled to provide region-specific data. For example, in DWR's report *Progress on Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report* (DWR 2006), four scenarios projecting regional climate change were selected, consisting of combinations of two different global climate models and two different emissions scenarios. These four scenarios provide temperature results ranging from weak warming to relatively strong warming, and precipitation results ranging from modest reductions to weak increases (DWR 2006).

It should be remembered that results of climate change modeling, particularly for regional models, are not specific, quantified predictions. There is a lot of uncertainty about the magnitude of climate change that will occur during this century. It is unlikely that this level of uncertainty will be resolved in the foreseeable future (Dettinger 2005a). Therefore, effects on the environment anticipated under various climate change models should be considered as general projections of potential future conditions, with actual environmental effects likely falling within the range of results provided by a variety of model outputs.

Temperature

Status and Trends

The Earth's climate has had periods of cooling and warming in the past. Significant periods of cooling have been marked by massive accumulations of sea- and land-based ice extending from the Earth's poles to as far as the middle latitudes. Periods of cooling have also been marked by lower sea levels because of the accumulation of water as ice and the cooling and contraction of the Earth's oceans. Periods of warming caused recession of the ice toward the poles, warming and thermal expansion of the Earth's oceans, and rise in sea levels (DWR 2006, IPCC 2007).

The potential for human-induced changes in the Earth's temperature has been tied to increased concentrations of GHGs in the atmosphere, caused primarily by the production and burning of fossil fuels. The primary gases of concern are carbon dioxide, methane, and nitrous oxide (IPCC 2001a, 2001b, 2007). Average temperatures in the Northern Hemisphere appear to have been relatively stable from about the year 1000 to the mid-1800s, based on temperature proxy records from tree rings, corals, ice cores, and historical observations (IPCC 2001a). However, there is a level of uncertainty related to proxy temperature records, especially those extending far back into the past.

The IPCC stated that the Earth's climate has warmed since the preindustrial era and that it is very likely that at least some of this change is attributable to the activities of humans (IPCC 2007). Global average near-surface air temperatures and ocean surface temperatures increased by 0.74 °C ± 0.18°C (1.33°F ± 0.32°F) during the 20th century (IPCC 2007).

Temperature measurements, apparent trends in reduced snowpack and earlier runoff, and other evidence such as changes in the timing of blooming plants indicate that temperatures in California and elsewhere in the western United States have increased during the past century (National Oceanic and Atmospheric Administration [NOAA] 2005, Mote et al. 2005, Cayan et al. 2001).

Projections

Modeling results from GCMs are consistent in predicting increases in temperatures globally with increasing concentrations of atmospheric GHGs resulting from human activity. As discussed above, climate change projections can be developed on a regional basis using techniques to downscale from the results of global models (although increased uncertainty results from the downscaling). One relatively large group of model projections for California that was recently examined provides a temperature rise of about 2.5 to 9°C (4.5 to 16.2°F) for Northern California by 2100. An analysis of the distribution of the projections generally showed a central tendency at about 3°C (5.4°F) of rise for 2050, and about 5°C (9°F) for 2100 (Dettinger 2005b).

Snyder et al. (2002) produced one of the most refined scale temperature and precipitation estimates to date. Resulting temperature increases for a scenario of doubled carbon dioxide concentrations are 1.4 to 3.8°C (2.5 to

6.8°F) throughout California. This is consistent with the global increases predicted by the IPCC (2001b, 2007). In a regional model of the western United States, Kim et al. (2002) projected a climate warming of around 3 to 4°C (5.4 to 7.2°F). Of note in both studies is the projection of uneven distribution of temperature increases. For example, regional climate models show that the warming effects are greatest in the Sierra Nevada, with implications for snowpack and snowmelt (Kim et al. 2002, Snyder et al. 2002).

Effect on the Project

Based on the results of a variety of regional climate models, it is reasonably foreseeable that some increase in annual average temperatures will occur in California, and in the project vicinity, during the next 100 years. Although a temperature increase is expected, the amount and timing of the increase is uncertain. In general, predictions put an increase in the range of 3 to 5°C (5.4 to 9°F) over the next 50–100 years (Kim et al. 2002, Snyder et al. 2002, Dettinger 2005b).

An increase in average annual temperatures, by itself, would have little effect on the proposed land uses other than adjustments in project operations in response to warmer temperatures, such as increased evapotranspiration rates affecting both detention basin areas and landscaped areas, resulting in an increased irrigation demand, and potentially greater overall energy consumption to meet air conditioning needs.

Effects related to water supply is discussed below. Potential outcomes of increased temperature on a global and regional scale, such as changes in precipitation and runoff, also have a potential to substantially affect physical conditions in the project vicinity. These topic areas are also discussed below.

Therefore, although an increase in annual average temperature is a reasonably foreseeable effect of future climate change, this environmental change alone would have little effect on the project.

Precipitation

Climate change can affect precipitation in a variety of ways, such as by changing the following:

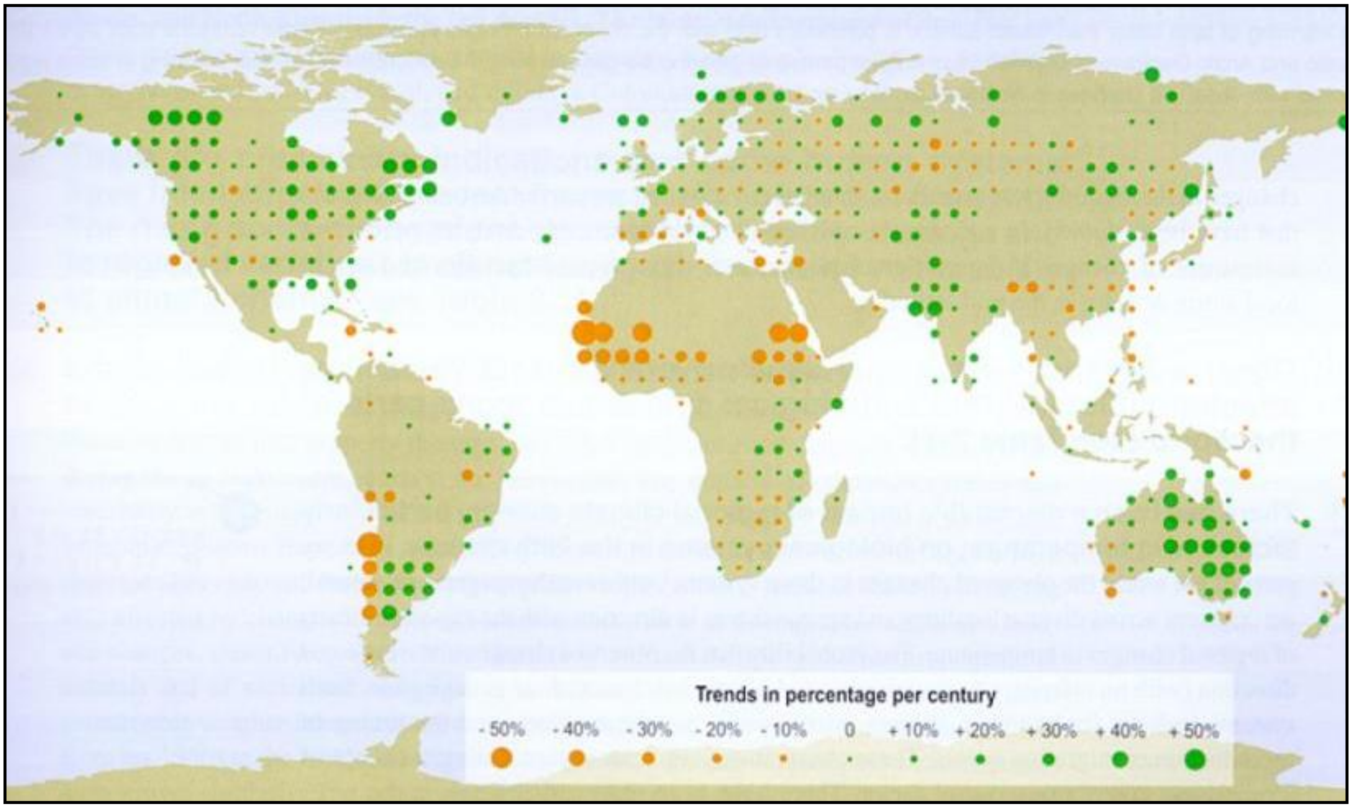
- overall amount of precipitation,
- type of precipitation (rain versus snow), and
- timing and intensity of precipitation events.

Each of these issue areas is discussed below.

Amount of Precipitation

Status and Trends

Worldwide precipitation is reported to have increased about 2% since 1900. While global average precipitation has been observed to increase, changes in precipitation over the past century vary in different parts of the world. Some areas have experienced increased precipitation while other areas have experienced a decline (Exhibit 3.4-2) (IPCC 2001b, 2007; NOAA 2005). An analysis of trends in total annual precipitation in the western United States by the National Weather Service's Climate Prediction Center provides evidence that annual precipitation has increased in much of California, the Colorado River Basin, and elsewhere in the West since the mid-1960s (DWR 2006). In another study evaluating trends in annual November through March precipitation for the western United States and southwest Canada, the data indicate that for most of California and the Southwest there was increasing precipitation during the periods of 1930–1997 and 1950–1997 (Mote et al. 2005).



Source: Adapted by AECOM in 2009 from IPCC 2001

Global Precipitation Trend for 1900–2000 **Exhibit 3.4-2**

Former State Climatologist James Goodridge compiled an extensive collection of longer-term precipitation records from throughout California. These data sets were used to evaluate whether there has been a changing trend in precipitation in the state over the past century (DWR 2006). Long-term runoff records in selected watersheds in the state were also examined. Based on a linear regression of the data, the long-term historical trend for statewide average annual precipitation appears to be relatively flat (no increase or decrease) over the entire record. However, an upward trend in precipitation during the latter portion of the record has been noted, but is not conclusive.

When these same precipitation data are sorted into three regions—northern, central, and southern California—trends show that precipitation in the northern portion of the state appears to have increased slightly from 1890 to 2002, and precipitation in the central and southern portions of the state show slightly decreasing trends. All changes were in the range of 1–3 inches annually (DWR 2006). Thus although existing data indicate some level of change in precipitation trends in California, more analysis is likely needed to determine whether changes in California's regional annual precipitation totals have occurred as the result of climate change or other factors (DWR 2006).

Projections

The IPCC predicts that increasing global surface temperatures are very likely to result in changes in precipitation. Global average precipitation is expected to increase during the 21st century as the result of climate change, based on global climate models for a wide range of greenhouse gas emission scenarios. However, global climate models are generally not well suited for predicting regional changes in precipitation because of the large scale of global projections relative to the small scale of regionally important factors that affect precipitation (e.g., maritime influences, effects of mountain ranges) (IPCC 2001a, 2007).

Therefore, while precipitation is generally expected to increase on a global scale as a result of climate change, significant regional variations in precipitation trends can be expected. Some recent regional modeling efforts conducted for the western United States indicate that overall precipitation will increase (Kim et al. 2002, Snyder et al. 2002), but considerable uncertainty remains because of differences among larger-scale GCMs. Where precipitation is projected to increase in California, the increases are mostly in northern California (Kim et al. 2002, Snyder et al. 2002) and in the winter months.

Various California climate models provide mixed results regarding changes in total annual precipitation in the state through the end of this century. Models predicting the greatest amount of warming generally predict moderate decreases in precipitation, while models projecting smaller increases in temperature tend to predict moderate increases in precipitation (Dettinger 2005b). In addition, an IPCC review of multiple global GCMs indicates that fewer than 66% of the models evaluated agree on whether annual precipitation would increase or decrease for much of the State's area. Therefore, no conclusion on an increase or decrease can be provided (IPCC 2007). Considerable uncertainties about the precise effects of climate change on California (and more specifically Sacramento River hydrology and water resources will remain until there is more precise and consistent information about how precipitation patterns, timing, and intensity will change.

Effect on the Project

Although global climate change models generally predict an increase in overall precipitation on a worldwide scale, there is no such consistency among the results of regional models applied to California. Based on the models used and the input assumptions, both increases and decreases in annual precipitation are projected. There is also variability in the results for different parts of the state. Given the uncertainty associated with projecting the amount of annual precipitation, any conclusion regarding significance of potential effects of climate change on precipitation volumes as they relate to reasonably foreseeable direct effects on physical conditions in the project vicinity would be too speculative to be meaningful.

Type of Precipitation – Snowpack

Status and Trends

California's annual snowpack, on average, has the greatest accumulations from November through the end of March. The snowpack typically melts from April through July. Snowmelt provides significant quantities of water to streams and reservoirs for several months after the annual storm season has ended. The length and timing of each year's period of snowpack accumulation and melting varies based on temperature and precipitation conditions (DWR 2006).

California's snowpack is important to the state's annual water supply because of its volume and the time of year that it typically melts. Average runoff from melting snowpack is usually about 20% of the state's total annual natural runoff and roughly 35% of the state's total usable annual surface water supply. The state's snowpack is estimated to contribute an average of about 15 million acre-feet (maf) of runoff each year, about 14 maf of which is estimated to flow into the Central Valley. In comparison, total reservoir capacity serving the Central Valley is about 24.5 maf in watersheds with significant annual accumulations of snow (DWR 2005b).

California's reservoir managers (including State Water Project [SWP] and Central Valley Project [CVP] facilities) use snowmelt to help fill reservoirs once the threat of large winter and early spring storms and related flooding risks have passed. These systems include water management infrastructure within the Sacramento River watershed, where additional water is stored in reservoirs and used to help meet downstream water demands after flows from snowmelt begin to recede. Some of the annual runoff collected in California's reservoirs is held from one year to the next because California's annual precipitation and snowpack can vary significantly from year to year. There may also be decade-scale variation in precipitation over the Sierra Nevada (Freeman 2002), and possibly other parts of California. Carryover storage can help meet water demand in years when precipitation and runoff is low.

Because the importance of the Sierra Nevada snowpack is tied to both the volume of water it holds and the timing of water releases (spring and early summer), simply assessing the amount of precipitation that falls as snow does not convey the full value of the snowpack and the potential effects of climate change on water supply. Measurements of the amount of Sierra Nevada runoff occurring from April to July are a better indicator of the combined interaction between the volume of the snowpack and the time of year that it melts.

Changes in patterns of runoff reveal declining water storage in the form of snowpack. Between 1906 and 2005, the total water year runoff in the Sacramento Valley rivers (including the Sacramento, Feather, Yuba, and American Rivers) has remained about the same (DWR 2006). However, runoff volume for April–July has declined from approximately 43% of total water-year runoff to approximately 34% of total water year runoff (i.e., has declined about 9% as compared to total year runoff). These values represent “unimpaired” runoff, meaning that the effects of runoff detention in reservoirs are removed. These data indicate that although overall precipitation volumes (represented by runoff amounts) showed no change, more runoff occurred as a result of rain during the winter months, and less runoff could be attributed to the melting of accumulated snowpack during the spring and early summer. These trends suggest less accumulation of snowpack and earlier runoff of snow melt.

Projections

As early as the mid-1980s and early 1990s, regional hydrologic modeling of global warming impacts has suggested with increasing confidence that higher temperatures will affect the timing and magnitude of snowmelt and runoff in California (Gleick 1986, 1997; Lettenmaier and Gan 1990; Lettenmaier and Sheer 1991; Nash and Gleick 1991; Hamlet and Lettenmaier 1999). Over the past two decades, this has been one of the most persistent and well-established findings on the impacts of climate change for water resources in the United States and elsewhere, and it continues to be the major conclusion of regional water assessments (Knowles and Cayan 2002, Barnett et al. in prep.).

By delaying runoff during the winter months when precipitation is greatest, snow accumulation in the Sierra Nevada acts as a massive natural reservoir for California. Despite uncertainties about how increased concentrations of greenhouse gases may affect precipitation, there is very high confidence that higher temperatures will lead to dramatic changes in the dynamics of snowfall and snowmelt in watersheds with substantially more snowfall (Kiparsky and Gleick 2005, DWR 2006). An analysis of the impact of rising temperatures on snowpack conducted by DWR (2006) shows that a 3°C (5.4°F) rise in average annual temperature would likely cause snowlines to rise approximately 1,500 feet. This would result in an annual loss of approximately 5 million acre-feet of water storage in snowpack. Simulations conducted by N. Knowles and D. R. Cayan (Knowles and Cayan 2002) project a loss in April snowpack in the Sierra Nevada of approximately 5% with a 0.6°C (1.1°F) increase in average annual temperature, and approximately 33% loss with a 1.6°C (3.4°F) rise, and an approximately 50% loss in April snowpack with a 2.1°C (4.9°F) average annual temperature rise. Loss of snowpack was projected to be greater in the northern Sierra Nevada and the Cascades than in the southern Sierra Nevada because of the greater proportion of land at the low and mid-elevations in the northern ranges. With a temperature increase of 2.1°C, the northern Sierra Nevada and the Cascades were projected to lose 66% of their April snowpack, while the southern Sierra Nevada was projected to lose 43% of its April snowpack (Knowles and Cayan 2002).

Future predictions confirm that not only will snowpack form a smaller portion of overall precipitation but it will also melt and runoff earlier in the year in the Sacramento watershed and its constituent subbasins (Gleick and Chalecki 1999). This change will occur as overall precipitation will likely increase slightly. These two trends will most likely cause reduced summer flows in the Sacramento River, reduced summer soil moisture and increased winter flows and flood potential. Higher snowlines will cause a greater proportion of winter runoff and earlier snowmelt times will lengthen the duration of peak winter flows and flood potential.

Effect on the Project

Based on the results of a variety of regional climate models and literature, it is reasonably foreseeable that snowpack will be reduced and/or will melt earlier or more rapidly in watersheds that feed the Sacramento River. The SPA is located in the foothills east of the Sacramento Valley and receives snow very rarely. Consequently, changes in snowfall patterns would not directly affect precipitation in the SPA.

However, changes in snowpack could affect the project indirectly by altering the timing and volume of runoff that eventually feeds into the SPA and into waterways supplying water to the project. Impacts to snowpack and associated runoff affecting the Sacramento River watershed are the most salient to proposed land uses in the project vicinity. The runoff sources can be divided into two categories: (1) direct rainfall-fed surface runoff accumulating in channels; and (2) released water from upstream reservoirs that is conveyed by the channels and will be used for groundwater recharge. The first source, direct surface runoff, will vary with large-scale regional changes in precipitation patterns. Because much of the naturally occurring runoff relevant to water supplies for the project originates as rainfall rather than snowfall (much of the Sacramento River watershed occurs in the Sacramento Valley itself and thus below the snowline), changes to the timing and magnitude of naturally occurring rainfall patterns will follow regional changes associated with climate change in the central and northern Sierra Nevada. The second source, released and/or purchased waters stored in upstream reservoirs, will largely depend on regional annual average precipitation accumulations. The management of upstream reservoirs may need to be altered to account for seasonal variations in precipitation type and intensity. However, the total water volumes stored in upstream reservoirs is largely tied to regional trends of annual average precipitation amounts. The predicted shift towards greater precipitation with a larger proportion of rainfall relative to snow will require greater upstream management in reservoirs and other flood control devices to maintain the current level of flood protection. Given the complex system of upstream water management, the impact of predicted climate changes on the project is speculative, but flood potential will probably increase if water management strategies remain the same. However, given that the magnitude and timing of the increase in winter runoff and the associated changes in reservoir use that may occur, the exact impact on the Proposed Project Alternative is speculative. Based on the uncertainty of projected changes it is not feasible or useful to mitigate anticipated changes in current planning.

Timing and Intensity of Precipitation Events

Status and Trends

Variability and extreme weather events are a natural part of any climatic system. The extent of climatic stability or variability is dependent in large part on the time frame examined. Climatic conditions may be characterized as relatively stable over periods of hundreds or thousands of years, but within that time frame there may be severe droughts or flood events that vary widely beyond the overall average condition. Paleoclimatic evidence from tree rings, buried stumps, and lakebed sediment cores suggests that in California the past 200 years have been relatively wet and relatively constant when compared with older records (DWR 2006). These older records reveal greater variability than the historical record, in particular in the form of severe and prolonged droughts, but are not likely to be as reliable as more recent records. Most identified climatic averages and extremes for California are based on the historical climate record since 1900, and cannot be considered fully representative of past or future conditions (DWR 2006).

Extreme weather events are expected to be one of the more important indicators of climate change. Phenomena such as the El Niño/Southern Oscillation, which is the strongest natural interannual climate fluctuation, affect the entire global climate system and the economies and societies of many regions and nations. Direct effects of this climate fluctuation occur in California. The El Niño/Southern Oscillation phenomena for example, strongly influences storms and precipitation patterns. It is unclear how increases in global average temperatures associated with global warming might affect the El Niño cycles. However, the strong El Niños of 1982–83 and 1997–98 and associated flood events, along with the more frequent occurrences of El Niños in the past few decades, have forced researchers to try to better understand how human-induced climate change may affect interannual climate variability (Trenberth and Hoar 1996, Timmermann et al. 1999).

In addition to possible long-term changes in precipitation trends, increased variability of annual precipitation is a possible outcome of climate change. Based on a statistical analysis of California precipitation records, there appears to be an upward trend in the variability of precipitation over the 20th century, with variability values at the end of the century about 75% larger than at the beginning of the century. This indicates that there tended to be more extreme wet and dry years at the end of the century than there were at the beginning of the century (DWR 2006). However, as stated above, paleoclimatic evidence suggests that weather patterns in California have been relatively constant over the last 200 years, which identifies the variable weather patterns toward the latter part of this period as more pronounced. As identified previously in the "Amount of Precipitation" discussion, there has been little change in the average amount of annual precipitation in California over the last 100 years. Therefore, the increased variability between wet and dry years in recent decades appears to oscillate around the same annual average established over a longer time frame.

Projections

While variability is not well modeled in large-scale GCMs, some modeling studies suggest that the variability of the hydrologic cycle increases when mean precipitation increases, possibly accompanied by more intense local storms and changes in runoff patterns (DWR 2006). However, the results of another long-standing model point to an increase in incidents of drought, resulting from a combination of increased temperature and evaporation along with decreased precipitation (DWR 2006). Based on the first model mentioned, this decrease in precipitation would lead to reduced variability in hydrologic cycles.

A study that analyzed 20 GCMs currently in use worldwide suggests that the West Coast may be less affected by extreme droughts than other areas; instead, the region would experience increased average annual rainfall (Meehl et al. 2000). A separate study that reviewed several GCM scenarios showed increased risk of large storms and flood events for California. Conflicting conclusions about climatic variability and the nature of extreme weather events (e.g., droughts, severe storms, or both) support the need for additional studies with models featuring higher spatial resolution (Kiparsky and Gleick 2005, DWR 2006).

Effect on the Project

Although various climate change models predict some increase in variability of weather patterns and an increasing incidence of extreme weather events, there is no consistency among the model results, with some predicting increased incidents of droughts and others predicting increased frequency of severe storm events. Given the uncertainty associated with projecting the type and extent of changes in climatic variability and the speculative nature of predicting incidents of extreme weather events, the effect on the project of changing patterns of storms and other extreme weather remains unclear, and the attempt to reach a significance conclusion would be speculative.

Runoff

Status and Trends

Runoff is directly affected by changes in precipitation and snowpack (see discussions above). Changes in both the amount of runoff and in seasonality of the hydrologic cycle have the potential to greatly affect the heavily managed water systems of the western United States.

As described in the previous discussion of snowpack, data indicate that although overall precipitation volumes (represented by runoff amounts) showed no change, more runoff occurred as a result of rain during the winter months, and less runoff could be attributed to the melting of accumulated snowpack during the spring and early summer (DWR 2006).

Projections

Detailed estimates of changes in runoff as a result of climate change have been produced for California using regional hydrologic models. With input of anticipated, hypothetical, and/or historical changes in temperature and precipitation in to models that include realistic small-scale hydrology, modelers have consistently seen substantial changes in the timing and magnitude, which can be attributed to runoff resulting from projected changes in climatic variables (Kiparsky and Gleick 2005). Model results indicate that as temperatures rise, a declining proportion of total precipitation falls as snow, more winter runoff occurs, and remaining snow melts sooner and faster in spring (Knowles and Cayan 2002, Gleick and Chalecki 1999). In some basins, spring peak runoff may increase; in others, runoff volumes may shift to earlier in the spring and winter months (Kiparsky and Gleick 2005, DWR 2006). If snowpack declines, it is also possible that the incidence or severity of flood events resulting from “rain on snow” conditions could also decline.

As indicated above, hydrology in the lower reaches of the Sacramento Valley is highly dependent on the interaction between Sierra Nevada snowpack, runoff, and management of reservoirs. Potential changes made to the amount of reservoir space retained for flood storage, retained annual carryover volumes, and other reservoir management factors in response to altered Sierra Nevada runoff patterns could substantially alter how those runoff patterns are experienced in downstream in the vicinity of the project vicinity. It is also possible that as climate change continues to progress over the next 50–100 years, new water storage projects (e.g., on-stream or off-stream storage reservoirs, expanding capacity at existing reservoirs) may be put in place to capture additional Sierra runoff. Additional storage capacity could assist in buffering runoff patterns in the lower river reaches from altered flow regimes in higher elevations.

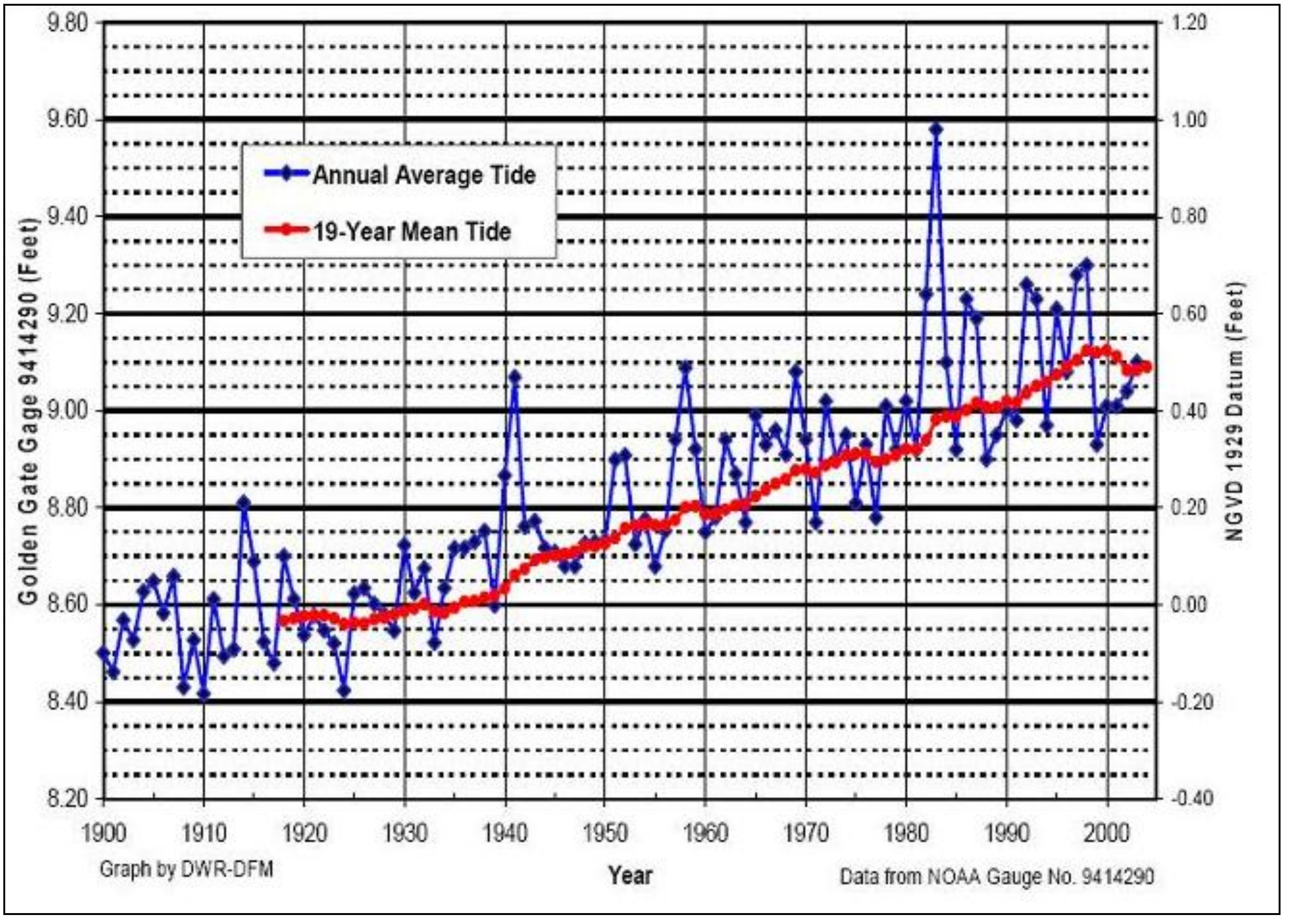
Effect on the Project

Although various climate change models consistently predict reduced spring/summer runoff in the Sierra Nevada as a result of altered snowpack conditions, there is a great deal of uncertainty regarding how these changes would affect runoff patterns in the Sacramento Valley and consequently water dependent land uses in the Sacramento Valley and foothills. Potential modifications in management regimes of existing reservoirs, such as reducing retained annual carryover volumes to increase space available for flood storage, could buffer the Sacramento River and adjacent land uses from changes to runoff patterns at higher elevations. The potential for creation of new water storage capacity, such as on- or off-stream storage reservoirs or expanding capacity at existing reservoirs could also reduce the effects of altered runoff patterns. Given the integrated nature of the water system in California, even increased storage capacity in southern California could benefit the region by allowing reservoirs in northern California to hold less water for domestic or agriculture use and retain more capacity for flood control. Given the uncertainty associated with projecting changes in runoff patterns in water bodies at and upstream of the project vicinity (the Sacramento River watershed is approximately 27,000 square miles, most of which occurs upstream of the project vicinity, and contains numerous subbasins) this potential climate change effect is too speculative to reasonably draw a meaningful conclusion regarding the significance of foreseeable direct effects on physical conditions in the project vicinity.

Sea Level

Status and Trends

One of the major areas of concern related to global climate change is rising sea level. Worldwide average sea level appears to have risen about 0.4 to 0.7 foot over the past century based on data collected from tide gauges around the globe, coupled with satellite measurements taken over approximately the last 15 years (IPCC 2007). Various gauge stations along the coast of California show an increase similar to the global trends. Data specific to the San Francisco tide gauge near the Golden Gate Bridge shows that the 19-year mean tide level (the mean tide level based on 19-year data sets) has increased by approximately 0.5 foot over the past 100 years (Exhibit 3.4-3). Rising average sea level over the past century has been attributed primarily to warming of the world’s oceans and the related thermal expansion of ocean waters, and the addition of water to the world's oceans from the melting of land-based polar ice. Some researchers have attributed most of the worldwide rise to thermal expansion of water, although there is some uncertainty about the relative contributions of each cause (Munk 2002).



Source: Adapted by AECOM in 2009 from DWR 2006

Graph of Annual Average Relative Sea Level and the 19-Year Running Average Sea Level at the Golden Gate Tide Gauge, California, 1900–2003 **Exhibit 3.4-3**

Effect on the Project

Projections

Various global climate change models have projected a rise in worldwide average sea level of 0.3 to 2.9 feet by 2100 (IPCC 2001a). Updated model results provided by the IPCC in 2007 put the range at 0.6–1.9 feet by 2099 (IPCC 2007). The ranges are narrower than in the Third Assessment Report (IPCC 2001a) mainly because of improved information about some uncertainties in the projected contributors to sea level rise (IPCC 2007).

Although these projections are on a global scale, the rate of relative sea level rise experienced at many locations along California's coast is consistent with the worldwide average rate of rise observed over the past century. Therefore, it is reasonable to expect that changes in worldwide average sea level through this century will also be experienced by California's coast (DWR 2006).

A consistent rise in sea level has been recorded worldwide over the last 100 years. Recorded rises in sea level along the California coast correlate well with the worldwide data. Based on the results of various global climate change models, sea level rise is expected to continue. Based on the consistency in past trends, the consistency of future projections, and the correlation between data collected globally and data specific to California, it is reasonably foreseeable that some amount of sea level rise will occur along the California coast over the next 100 years. Although sea level rise is expected to occur, the amount and timing of the increase is uncertain.

Predictions published by the IPCC in 2007 indicate an increase in elevation in the range at 0.6–1.9 feet by 2099 (IPCC 2007).

While sea level rise induced by climate change is reasonably certain, the SPA is located far above (over 100 feet above) sea level, and thus sea level rise would not directly affect proposed land uses within the SPA.

Water Supply

Status and Trends

Several recent studies have shown that existing water supply systems are sensitive to climate change (Wood et al. 1997). Potential impacts of climate change on water supply and availability could directly and indirectly affect a wide range of institutional, economic, and societal factors (Gleick 1997). Residential, industrial, and agricultural land uses all are affected by the cost and security of water supply. Much uncertainty remains, however, with respect to the overall impact of global climate change on future water supplies. For example, models that predict drier conditions (i.e., parallel climate model [PCM]) suggest decreased reservoir inflows and storage and decreased river flows, relative to current conditions. By comparison, models that predict wetter conditions (i.e., HadCM2) project increased reservoir inflows and storage, and increased river flows (Brekke et al. 2004). Both projections are equally probable based on which model is chosen for the analyses (Brekke et al. 2004). Much uncertainty also exists with respect to how climate change will affect future demand on water supply (DWR 2006). Still, changes in water supply are expected to occur and many regional studies have shown that large changes in the reliability of water yields from reservoirs could result from only small changes in inflows (Kiparsky and Gleick 2005; see also Cayan et al. 2006).

Little work has been performed on the effects of climate change on specific groundwater basins or groundwater recharge characteristics (Kiparsky and Gleick 2005). Changes in rainfall and changes in the timing of the groundwater recharge season would result in changes in recharge. Warmer temperatures could increase the period where water is on the ground by reducing soil freeze. Conversely, warmer temperatures could lead to higher evaporation or shorter rainfall seasons, which could mean that soil deficits would persist for longer time periods, shortening recharge seasons. Warmer, wetter winters would increase the amount of runoff available for groundwater recharge. This additional winter runoff, however, would be occurring at a time when some basins, particularly in Northern California, are being recharged at their maximum capacity. Reductions in spring runoff and higher evapotranspiration, on the other hand, could reduce the amount of water available for recharge. However, the specific extent to which various meteorological conditions will change and the impact of that change on groundwater are both unknown. A reduced snowpack, coupled with increased rainfall, could require a change in the operating procedures for California’s existing dams and conveyance facilities (Kiparsky and Gleick 2005).

Projections

DWR’s *Progress on Incorporating Climate Change into Management of California’s Water Resources, Technical Memorandum Report* (2006) focused on climate change impacts on CVP and SWP operations and on the Delta. The results of that analysis suggest several impacts of climate change on overall CVP and SWP operations and deliveries. In three of the four climate scenarios simulated, CVP reservoirs north of the Delta experienced shortages during droughts. DWR (2006) recommends that future studies examine operational changes that could avoid these shortages. At present, DWR concludes, it is not clear whether such operational changes would be insignificant or substantial. Changes in annual average CVP deliveries south of the Delta ranged from increases of about 2.5% for the wetter scenario to decreases of up to 10% for drier scenarios. Future studies will have to address how shortages north of the Delta could affect CVP deliveries south of the Delta. Carryover storage (i.e., water from one year stored into the next year) for the CVP was negatively affected in the drier scenarios and beneficially affected (slightly increased) in the wetter scenario.

The modeling conducted by Gleick and Chalecki (1999) on the Sacramento River Basin strongly suggests that annual levels of water moving through the Sacramento River watershed would increase. While annual volumes of water would increase, summer flows would decrease as a result of projected reductions in snowpack and earlier seasonal melting. Absent any intervention this would result in lower summer surface water flows and higher winter flows. Groundwater recharge may be adversely impacted by lower summer flows, without a commensurate increase because winter recharge rates are already at maximum. Upstream water management structures such as reservoirs could mitigate this by retaining greater winter flows to be released during the summer, thus making for a more constant level of surface water in the Sacramento. The need for adaptive changes in water management infrastructure use suggested by Gleick and Chalecki is confirmed by more recent research.

Tanaka et al. (2006) explored the ability of California's water supply system to adapt to long-term climatic and demographic changes using the California Value Integrated Network (CALVIN), a statewide economic-engineering optimization model of water supply management. The results show agricultural water users in the Central Valley are the most sensitive to climate change, particularly under the driest and warmest scenario (i.e., PCM 2100) predicting a 37% reduction of Central Valley agricultural water deliveries and a rise in Central Valley water scarcity costs by $1.7 billion. Although the results of the study are only preliminary, they suggest that California's water supply system appears "physically capable of adapting to significant changes in climate and population, albeit at a significant cost" (Tanaka et al. 2006). Such adaptation would entail changes in California's groundwater storage capacity, water transfers, and adoption of new technology.

VanRheenen et al. (2004) studied the potential effects of climate change on the hydrology and water resources of the Sacramento-San Joaquin River Basin using five PCM scenarios. The study concluded that most mitigation alternatives examined satisfied only 87 to 96% of environmental targets in the Sacramento system, and less than 80% in the San Joaquin system. Therefore, system infrastructure modifications and improvements could be necessary to accommodate the volumetric and temporal shifts in flows predicted to occur with future climates in the Sacramento-San Joaquin River Basins.

Zhu et al. (2005) studied climate warming impacts on water availability derived from modeled climate and warming streamflow estimates for six index California basins and distributed statewide temperature shift and precipitations changes for 12 climate scenarios. The index basins provide broad information for spatial estimates of the overall response of California's water supply and the potential range of impacts. The results identify a statewide trend of increased winter and spring runoff and decreased summer runoff, as previously indicated by Gleick and Chalecki (1999). Approximate changes in water availability are estimated for each scenario, though without operations modeling. Even most scenarios with increased precipitation result in a decrease in available water. This result is due to the inability of current storage systems to catch increased winter streamflow to offset reduced summer runoff.

Medellin et al. (2006) used the CALVIN model under a high emissions "worst case" scenario, called a dry-warming scenario. The study found that climate change would reduce water deliveries by 17% in 2050. The reduction in deliveries was not equally distributed, however, between urban and agricultural areas. Agricultural areas would see their water deliveries drop by 24% while urban areas would only see a reduction of 1%. There was also a geographic difference: urban scarcity was almost absent outside of southern California.

In 2003, CEC's Public Interest Energy Research (PIER) program established the California Climate Change Center (CCCC) to conduct climate change research relevant to the state. Executive Order S-3-05 called for the CalEPA to prepare biennial science reports on the potential impact of continued climate change on certain sectors of California's economy. CalEPA entrusted PIER and its CCCC to lead this effort. The climate change analysis contained in its first biennial science report concluded that major changes in water management and allocation systems could be required in order to adapt to the change. As less winter precipitation falls as snow, and more as rain, water managers would have to balance the need to construct reservoirs for water supply with the need to maintain reservoir storage for winter flood control. Additional storage could be developed, but at high environmental and economic costs.

Lund et al. (2003) examined the effects of a range of climate warming estimates on the long-term performance and management of California's water system. The study estimated changes in California's water availability, including effects of forecasted changes in 2100 urban and agricultural water demands using a modified version of the CALVIN model. The main conclusions are summarized below.

- A broad range of climate warming scenarios show significant increase in wet season flows and significant decreases in spring snowmelt. The magnitude of climate change effects on water supplies is comparable to water demand increases from population growth in 21st century.
- California's water system would be able to adapt to the severe population growth and climate change modeled. This adaptation would be costly, but it would not threaten the fundamental prosperity of the state, although it could have major impacts on the agricultural sector. The water management costs represent only a small proportion of California's current economy.
- Under the driest climate warming scenarios, Central Valley agricultural users could be especially vulnerable to climate change. Wetter hydrologies could increase water availability for these users. The agricultural community would not be compensated for much of its loss under the dry scenario. The balance of climate change effects on agricultural yield and water use is unclear. While higher temperatures could increase evapotranspiration, longer growing seasons and higher carbon dioxide concentrations could increase crop yield.
- Population growth is expected to be more problematic than climate change in Southern California. Population growth, conveyance limits on imports, and high economic value of water in Southern California, could lead to high use of wastewater reuse and substantial use of seawater desalination along the coast. Due to the integrated nature of water management and competition for water resources this could impact water supply in the Sacramento region.
- Under some wet warming climate scenarios, flooding problems could be substantial. In certain cases, major expansions of downstream floodways and alterations in floodplain land use could become desirable.
- California's water system could economically adapt to all the climate warming scenarios examined in the study. New technologies for water supply, treatment, and water use efficiency, implementation of water transfers and conjunctive use, coordinated operation of reservoirs, improved flow forecasting, and the cooperation of local regional, state and Federal government can help California adapt to population growth and global climate change. However, if these strategies are implemented, the costs of water management are expected to be high and there is likely to be less "slack" in the system compared to current operations and expectations.

Effect on the Project

As described by the projections above, overall, climate change is expected to have a greater effect in Southern California and on agricultural users than urban users in the Central Valley, which includes both the San Joaquin and Sacramento Valleys. For example, for 2020 conditions, where optimization is allowed (i.e., using the CALVIN model), scarcity is not expected to be an issue in the Sacramento Valley for both urban and agricultural users, and generally not an issue for urban users in the San Joaquin and Tulare Basins. Rather, most water scarcity will be felt by agricultural users in Southern California. However, it is expected that Southern California urban users, especially Coachella urban users, will also experience some scarcity. By the year 2050, urban water scarcity there will be almost no water scarcity north of the Tehachapi Mountains, although agricultural water scarcity could increase in the Sacramento Valley to about 2% (Medellin et al. 2006; see also Tanaka et al. 2006 and Lund et al. 2003 for further discussion of global climate change impacts on agricultural uses).

Based on the conclusions of current literature regarding California's ability to adapt to global climate change, it is reasonably expected that over time, the state's water system will be modified to be able to address the projected climate changes, e.g., under dry and/or warm climate scenarios (DWR 2006). Although coping with climate change effects on California's water supply could come at a considerable cost, based on a thorough investigation of the issue, it is reasonably expected that statewide implementation of some, if not several, of the wide variety of adaptation measures available to the state, will likely enable California's water system to reliably meet future water demands. For example, traditional water supply reservoir operations may be used, in conjunction with other adaptive actions, to offset the impacts of global warming on water supply (Medellin et al. 2006; see also Tanaka et al. 2006 and Lund et al. 2003). Other adaptive measures include better urban and agricultural water use efficiency practices, conjunctive use of surface and ground waters, desalination, and water markets and portfolios (Medellin et al. 2006; see also Lund et al. 2003, Tanaka et al. 2006). More costly statewide adaptation measures could include construction of new reservoirs and enhancements to the state's levee system (CEC 2003).
As described by Medellin et al. 2006, with adaptation to the climate, the water deliveries to urban centers are expected to decrease by only 1%, with Southern California shouldering the brunt of this decrease.

Given these projections it is difficult to scale regional and state trends down to predict specific impacts in the project vicinity. The project would rely upon both surface water from the Sacramento River and groundwater pumping at the SPA and in the project vicinity (i.e., Vineyard and Mather groundwater wells) as part of the Sacramento County Water Agency's conjunctive use program. As described above for the discussions of snowpack and runoff, the effect of climate change on the Sacrament River watershed remains uncertain. Different models suggest either an increase or decrease in precipitation. While an increase in precipitation may increase potential surface and groundwater supply, existing storage facilities may need to be expanded to effectively capture and transfer such supplies. Additionally, an increase in precipitation may not effectively increase groundwater recharge if the increase occurs during seasons when aquifers are recharging at maximum capacity. Because there is uncertainty with respect to impacts of climate change on future water availability in California, in terms of whether and where effects will occur, and the timing and severity of any such potential effect, conclusions regarding significance would therefore be too speculative for meaningful consideration.

Water Quality

Status and Trends

Water quality depends on a wide range of interacting variables, such as water temperatures, flows, runoff rates and timing, waste discharge loads, and the ability of watersheds to assimilate wastes and pollutants. Surface water quality in the Sacramento Valley has experienced substantial adverse effects from human activities, including contaminant inputs from urban, industrial, and agricultural sources; and increased temperature from removal of shading vegetation. Historic activities such as gold mining in the nineteenth century created long-term impacts on regional water quality by contributing massive quantities of silt, minerals, and, notably, mercury that has settled into river bottom sediments.

Projections

Climate change could alter numerous water quality parameters in a variety of ways. Higher winter flows could reduce pollutant concentrations (through dilution) or increase erosion of land surfaces and stream channels, leading to higher sediment, chemical, and nutrient loads in rivers (DWR 2006). Increases in water flows could also decrease chemical reactions in streams and lakes, reduce the flushing time for contaminants, and increase export of pollutants to coastal areas (Mulholland et al. 1997, Schindler 1997). Decreased summer flows can exacerbate increases in temperature, increase the concentration of pollutants, increase flushing times, and increase salinity (Schindler 1997, Mulholland et al. 1997). Decreased surface-water flows can also reduce nonpoint-source runoff (Mulholland et al. 1997). Increased water temperatures can enhance the toxicity of metals in aquatic ecosystems (Moore et al. 1997). Increases in water temperature alone are often likely to lead to adverse changes in water quality, even in the absence of changes in precipitation (Kiparsky and Gleick 2005).

A review of potential impacts of climate change on water quality concludes that significant changes in water quality are known to occur as a direct result of short-term changes in climate (Murdoch, Baron, and Miller 2000). The review notes that water quality in ecological transition zones and areas of natural climate extremes is vulnerable to climate changes that increase temperatures or change the variability of precipitation. However, it is also argued that changes in land and resource use will have comparable or even greater impacts on water quality than changes in temperature and precipitation. A separate study concluded that changes in land use resulting from climatic changes, together with technical and regulatory actions to protect water quality, can be critical to future water conditions (Kiparsky and Gleick 2005). The net effect on water quality for rivers, lakes, and groundwater in the future is dependent not just on how climatic conditions might change, but also on a wide range of other human actions and management decisions. The most recent studies identify the likelihood that decreased runoff will interact with higher stream temperatures to exacerbate decreases in water quality (Backlund et. al. 2008:8).

Effect on the Project

Although there are various ways in which climate change could affect water quality, effects could be positive or negative depending on a variety of conditions. In addition, current water quality conditions in regional surface waters depend in large part on human activities, and this would continue into the future. The effects of climate change on water quality could be alleviated by, exacerbated by, or overwhelmed by effects directly related to localized human actions. Given the uncertainty associated with projecting the type and extent of changes in water quality attributable to climate change, including trying to project human activities, this potential climate change effect is too speculative to draw a conclusion regarding the significance of any direct effect on physical conditions in the project vicinity.

CONCLUSION

Seven general categories of potential effects of climate change were evaluated in this section:

- increased temperature;
- precipitation volume, type, and intensity;
- runoff volume and timing;
- water supply;
- sea level rise; and
- water quality.

This analysis concludes that (1) either the climate change effect would not have the potential to substantially affect the project vicinity, or (2) because of significant uncertainty in projecting future conditions related to the climate change effect, it would be too speculative to reach a meaningful conclusion regarding the significance of any reasonably foreseeable direct impact on physical conditions in the project vicinity. Therefore, impacts are too speculative for meaningful consideration.

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