Section 12 Climate Change

Climate change is a shift in the average weather that a given region experiences. This is measured by changes in the features that we associate with weather, such as temperature, wind patterns, precipitation, and storms. The Earth's climate has always been changing; however, the current climate change we are seeing today differs from previous climate change in both its rate and its magnitude.

Naturally occurring components of the Earth's atmosphere, primarily water vapor, CO_2, CH_4, and N_2O absorb heat radiated from the Earth's surface, warming the atmosphere in a process known as the greenhouse effect. Human activities are exerting a major and growing influence on some of the key factors that govern climate by changing the composition of greenhouse gases (GHG) in the atmosphere and modifying the land surface. For example, the concentration of CO_2 in the atmosphere has risen about 30 percent since the late 1800s[1].

California produces roughly 1.4 percent of the world's, and 6.2 percent of the total U.S., greenhouse gases[2]. The effects of climate change are already being seen on the hydrology of California. These effects include reduced mountain snowpack and glacial volume, increase in storm intensities, increase in temperatures of natural waters, sea level rise, and high variability in river flows. Planning for and adapting to the consequences of these hydrological changes including impacts on public safety, impacts to ecosystems, and long-term water supply reliability present water managers throughout southern California with significant challenges.

The Sierra snowpack provides as much as 65 percent of California's water supply by accumulating snow during our wet winters and releasing it slowly when we need it during our dry springs and summers. Warmer temperatures will cause what snow we do get to melt faster and earlier, making it more difficult to store and use. By 2050, scientists project a loss of at least 25 percent of the Sierra snowpack. This loss of snowpack means less water will be available for Californians to use.

These effects of climate change are expected to continue in the future and more of our precipitation will likely fall as rain instead of snow. This potential change in weather patterns will exacerbate flood risks and add additional challenges for water supply reliability. Climate change is also expected to result in more variable weather patterns throughout California. More variability can lead to longer and more severe droughts. In addition, the sea level will continue to rise, threatening the sustainability of the Sacramento-San Joaquin Delta, the heart of the California water supply

[1] Climate Action Team Report; Cal. EPA, March 2006
[2] California's Resource for Global Climate Change Information; www.climatechange.ca.gov

system and the source of water for 25 million Californians and millions of acres of prime farmland[3].

The collaborative process of water management through regional watershed planning provides a good framework for addressing the many aspects of climate change on water supply. This section of the NOC WMA Plan describes how the effects of climate change are considered with respect to the region's water management planning.

12.1 Potential Effects to North Orange County WMA

The North Orange County WMA imports its water from Northern California, (approximately 50 percent of its water supply) making the Region susceptible to climate change effects. Water planning in the NOC WMA region must also address adapting to changes in the amount, intensity, timing, quality, and variability of regional runoff and recharge due to changes in climate.

The effects of climate change most likely to affect the NOC WMA region are as follows:[4]

- Sea level rise
- Warmer temperatures changing mountain snowpack runoff
- Changes in precipitation and temperature affecting average runoff volume
- Changes in drought persistence
- Higher water temperature in streams and reservoirs
- Changes in water demands from higher temperatures and CO_2 concentrations
- Increased flood flows and flood frequencies

Sea level rise

Flooding and erosion already pose a threat to communities along the California coast, including Orange County, and there is compelling evidence that these risks will increase in the future. Based on a set of climate scenarios prepared for the California Energy Commission's Public Interest Energy Research (PIER) Climate Change Research Program, Cayan et al. (2009) project that, under medium to medium-high emissions scenarios, mean sea level along the California coast will rise from 1.0 to 1.4 meters by the year 2100[5].

In 2000, an estimated 72,000 Orange County residents lived in areas vulnerable to a 100-year flood event, the highest number for any California county. It is estimated that a 1.4 m sea level rise will increase the number of people vulnerable to a 100-year flood event to 110,0005.

[3] California Department of Water Resources; www.water.ca.gov/climatechange/
[4] Adapting California's Water Management to Climate Change, November 2008, as found in California Water Plan Update 2009, Volume 4 Reference Guide
[5] The Impacts of Sea-Level Rise on the California Coast, California Climate Change Center, May 2009.

Rising sea level has implications not only for coastal areas but also for the management of the Sacramento-San Joaquin Delta. The Delta region is a critical component of North Orange County's current water supply system. Sea level rise will raise the elevation of salt water at the Delta's western end. This will increase the risk of levee failure and seawater intrusion into the Delta's fresh water. Water supply effects of sea level rise are also likely in some coastal aquifers. Sea level rises could increase coastal erosion and impact coastal ecological resources such as estuaries and tidal wetlands.

Changing Mountain Snowpack Runoff

One of the most critical impacts for California water management may be the projected reduction in the Sierra Nevada snowpack, California's largest surface "reservoir". Snowmelt currently provides an annual average of 15 million acre-feet of water, slowly released between April and July of each year. Rising average temperatures throughout California will ultimately reduce the amount of mountain snowpack as more precipitation will fall as rain instead of snow and warmer weather will cause more snowpack to melt earlier in the year. The average early spring snowpack in the Sierra Nevada decreased by about 10 percent during the last century, a loss of 1.5 million acre-feet of snowpack storage[6].

Much of the state's water infrastructure was designed to capture the slow spring runoff and deliver it during the drier summer and fall months. Based on historical data and modeling, DWR projects that the Sierra snowpack will experience a 25 to 40 percent reduction from its historic average by 2050. Climate change is also anticipated to bring warmer storms that result in less snowfall at lower elevations, reducing the total snowpack. Reservoirs and groundwater basins that lie downstream of mountain snowpacks will likely experience large variations in water inflows, creating storage volume overflow at some times and drought conditions at other times.

Changes in Precipitation and Temperature Affecting Average Runoff

The effects of climate change on overall precipitation and runoff are less clear, but of great potential importance. The existing amount of surface storage on most major streams and water storage reservoir in southern California provides a fair amount of capacity to accommodate shifts in inflows for most years. However, any reduction of annual runoff volumes due to declines in precipitation or increase in evapotranspiration in reservoirs or the broader watersheds would directly reduce water supplies.

Changes in Drought Persistence

Droughts differ from typical emergency events such as floods or forest fires, in that they occur slowly over a multiyear period. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline. Droughts in

[6] Climate Change Adaptation Strategies for California's Water, DWR, 2008

the western U.S. are often persistent. The 2009 Water Year (October 1, 2008 – September 30, 2009) was the third consecutive year of below average precipitation for the state. Annual statewide precipitation totaled 76 percent, 72 percent, and 63 percent of average for Water Years 2009, 2008, and 2007, respectively[7]. As of June of the 2010 Water Year, statewide precipitation was below normal for a third year. Several key reservoirs dropped to near historic lows this season. Statewide storage remains well below average, impacting supply, recreation, and hydropower generation. North Orange County's reliance on imported water from throughout the state makes drought awareness one of the Region's highest concerns.

High Stream and Reservoir Temperatures

Higher temperatures overall will increase water temperatures throughout the system, including inflows into reservoirs, water stored within reservoirs, and water flowing downstream. Such increases will significantly affect ecosystem and human uses of the water system. Most species have evolved to survive within a specific temperature range. Increased water temperature can also reduce the amount of dissolved oxygen that it holds, affecting macro- and microorganisms alike.

Increased Water Demands

Higher temperatures and increases in CO_2 are likely to also change water demands throughout the state. These effects will vary considerably depending on other changes in the regional and global economy, population, and land use. The most important effect is likely to be on agricultural water demands. Higher temperatures generally increase evapotranspiration rates.

Urban water demands may also be affected by climate warming. Increases in evapotranspiration and growing season are likely to increase outdoor consumptive water use for landscaping, which accounts for half or more of residential water use in southern California.

Increased Flood Flows and Flood Frequencies

Increased intensity and frequency of major storms, another anticipated effect of climate change, would further augment flood problems in southern California. With continued increases in floodplain urbanization and the associated increase in damage potential, flooding costs from climate change could exceed those of water supply. The effects of changes in flood flows on ecosystems are less well studied but could be significant.

[7] California Department of Water Resources, Drought Conditions webpage: www.water.ca.gov/drought/conditions/

12.2 Legislative and Policy Context

There are three main pieces of policy and legislation that deal with climate change in the State of California. Executive Order (EO) S-3-05 and the California Global Warming Solutions Act of 2006 (AB 32; amending California Health and Safety Code Division 25.5, §38500, et seq.) lay the foundation for California's response to climate change. Senate Bill 97, signed by the Governor on August 24, 2007 initiated formal changes to the CEQA Guidelines that provides guidance for the way climate change is analyzed in CEQA documents by adding Section 21083.05 to the Public Resources Code.

EO S-3-05 made California the first state to formally establish GHG emissions reduction goals. EO S-3-05 includes the following GHG emissions reduction targets for California:

By 2010, reduce GHG emissions to 2000 levels
By 2020, reduce GHG emissions to 1990 levels
By 2050, reduce GHG emissions to 80 percent below 1990 levels

The final emission target of 80 percent below 1990 levels would put the state's emissions in line with estimates of the required worldwide reductions needed to bring about long-term climate stabilization and avoidance of the most severe impacts of climate change (Intergovernmental Panel on Climate Change (IPCC), 2007).

AB 32 further details and codifies the mid-term GHG reduction target established in EO S-3-05. AB 32 also identifies the California Air Resources Board (CARB) as the state agency responsible for the design and implementation of emissions limits, regulations, and other measures to meet the target.

SB 97 directed the Governor's Office of Planning and Research (OPR) to develop CEQA Guideline amendments for the analysis of climate change in CEQA documents for the approval of the Natural Resources Agency.

12.3 Consideration of Effects of Climate Change to Region

The Integrated Regional Water Planning Act, CWC §10541(e)(10), states that IRWM plans must include an evaluation of the adaptability to climate change of water management systems in the region. However, tools to properly assess the risk of any one effect of climate change on a region are not developed, and the abilities of different regions to use these tools vary considerably.

Local governments and agencies within the NOC WMA region play an essential role in fulfilling California's emissions reduction targets and in

reducing the local effects of climate change in the Region. Local governments have broad influence and, in some cases, exclusive authority over activities that contribute to significant direct and indirect greenhouse gas emissions through their planning and permitting processes, local ordinances, outreach and education efforts, and municipal operations.

Land use planning and urban growth decisions are also areas where successful implementation of climate change strategies relies on local government. Local governments have primary authority to plan, zone, approve, and permit how and where land is developed to accommodate population growth and the changing needs of their jurisdictions. Decisions on how land is used will have large impacts on the greenhouse gas emissions that will result from the transportation, housing, industry, forestry, water, agriculture, electricity, and natural gas sectors.

A resource management strategy is a project, program, or policy that helps local agencies and governments manage their water and related resources[8]. Section 5 of this NOC WMA Plan outlines a comprehensive and diverse set of resource management strategies to help meet the water-related management needs of the region. These strategies can be combined in various ways to meet the water management objectives of the region. Future decisions will factor in strategies for adapting to and mitigating climate change impacts.

The NOC WMA stakeholders understand that the Region's water supply is contingent upon amount, intensity, timing, quality, and variability of runoff and recharge, as well as on water imported from outside the region. Therefore, the NOC WMA stakeholders are committed to addressing the effects of climate change on the Region's water supply by incorporating climate change considerations into the region's resource management strategies. Likewise, as NOC WMA Plan projects are developed and selected for implementation, consideration of adapting to the effects of climate change will be a part of the project review process (see Section 6).

Among the various sources of information on climate change, the NOC WMA Stakeholders considered the following three documents during the development of resource management strategies and the selection of projects.

The Climate Change Scoping Plan that was adopted by CARB in 2008 discusses different business sectors including water management and recommends specific strategies that may help reduce GHG emissions.

DWR published a white paper, Managing an Uncertain Future: Climate Change Adaption Strategies for California's Water (2008), that urges a new approach to managing California's water and other natural resources in the

[8] California Water Plan Update 2009

face of climate change. The recommendations from the White Paper are incorporated into Volume 1 Chapter 7 of CWP Update 2009.

The California Natural Resource Agency (CNRA) has a report currently in draft form entitled 2009 California Climate Adaptation Strategy that discusses statewide and sector specific vulnerability assessments.

When it comes to water management considerations, water managers must include both adaptation and mitigation into their planning strategies.

Adaptation refers to the ways in which our society and culture will need to change to cope with a changing climate. Several of the resource management strategies and projects in this Plan will help the Region adapt to climate change.

Mitigation refers to the reduction of GHG emissions from water-related energy use. Water management results in the consumption of significant amounts of energy in California and the accompanying production of GHG emissions, especially where water must be pumped from long distances; from the ground; or over significant elevations. Water utilities use energy to reliably provide quality water to customers, while wastewater utilities in turn use energy to safely collect, treat, and dispose of wastewater to protect public health and the environment. GHG emissions reduction is a critical responsibility of water managers, and efficiency in water and energy use should be pursued at every opportunity. At the same time, water provides California with hydroelectric power, the state's largest source of GHG emissions-free energy.

The NOC WMA Stakeholders are aware of the detriment and cost that inaction on climate change would have on the Region. A warming California climate would generate more smoggy days by contributing to ozone formation while also fostering more large brush and forest fires. The NOC WMA region experienced two large damaging fires in 2007 and 2008 with the Santiago Fire and the Freeway Complex Fire respectively. Continuing increases in global greenhouse gas emissions at current rates would result, by late in the century, in California losing 90 percent of the Sierra snow pack, sea level rising by more than 20 inches, and a three to four times increase in heat wave days. These impacts will translate into real costs for California, including flood damage and flood control costs that could amount to several billion dollars in many regions. Water supply costs due to scarcity and increased operating costs would also increase.

Failing to address climate change also carries with it the risk of substantial public health costs, primarily as a result of rising temperatures. Sustained triple-digit heat waves increase the health risk for several segments of the population, especially the elderly. But higher average temperatures will also increase the interactions of smog-causing chemicals with sunlight and the atmosphere to produce higher volumes of toxic byproducts than would

otherwise occur. Low-income communities are disproportionately impacted by climate change, lacking the resources to avoid or adapt to these impacts. For example, low-income residents are less likely to have access to air conditioning to prevent heat stroke and death in heat waves. Taking action to help mitigate the impacts of climate change will help slow temperature rise. This in turn will likely result in fewer premature deaths from respiratory and heat-related causes, and many thousands fewer hospital visits and days of illness[9].

It is anticipated that as more information regarding the effects of climate change on the region becomes available, and as new technologies arise to slow or offset the impacts, the NOC WMA stakeholders will revise and update this Plan accordingly.

12.4 GHG Emission Analysis

Greenhouses gas emissions are directly related to the effects of climate change thus when selecting regional projects to implement, the NOC WMA stakeholders are dedicated to analyzing and providing GHG emissions generated from those projects.

CEQA Project Level Analysis

As mentioned previously, SB 97 directed the Governor's Office of Planning and Research to develop CEQA Guideline amendments for the analysis of climate change in CEQA documents for the approval of the Natural Resources Agency. On December 31, 2009, the Natural Resources Agency adopted amendments to the CEQA Guidelines for GHGs and sent them to the California Office of Administrative Law for approval and filing with the Secretary of State, http://www.ceres.ca.gov/ceqa/guidelines/. The Guideline amendments for GHG emissions fit within the existing CEQA framework for environmental analysis, which calls for lead agencies to determine baseline conditions and levels of significance, and to evaluate mitigation measures. The Guideline amendments do not identify a threshold of significance for GHG emissions nor do they prescribe assessment methodologies or specific mitigation measures. The Guidelines amendments encourage lead agencies to consider many factors in performing a CEQA analysis, but preserve the discretion that CEQA grants lead agencies to make their own determinations based on substantial evidence.

This CEQA project level analyses in the area of climate change may assist the NOC WMA region with a means of disclosing and evaluating GHG emissions of project alternatives. In preparing a project-level GHG emissions analysis, the WMA members and the project proponents should estimate GHG emissions from the project; establish significance criteria; identify those project components that may supply carbon sequestration;

[9] Climate Change Scoping Plan, CARB, October 2008

and, if applicable, explain how the project may help in the adaptation to effects of climate change.

Emission sources that are typically applicable to projects that may result in GHG reduction include:

- Operation of construction equipment
- Passenger vehicle trips during construction and operation
- Transportation of construction materials and equipment
- Transportation of material inputs for O&M
- Transportation of material outputs or production
- Generation of electricity used for operation of projects
- Waste generation and disposal of materials during construction and operation

Where appropriate, project analysis shall consider all known applicable BMPs or other mitigation measures to reduce GHG emissions. In considering the appropriate level of analysis for a specific project, the project proponent may utilize the OPR Technical Advisory on CEQA and Climate Change, the CAPCOA White Paper, CARB's early action measures, and the six key elements and the 39 measures for GHG reduction from the Climate Scoping Plan; the California Attorney General's Office website, and other relevant studies and resources.

California Climate Action Registry

As part of future climate change planning, the NOC WMA region shall consider joining the California Climate Action Registry (CCAR), www.climateregistry.org. The CCAR is a private non-profit organization that serves as a voluntary GHG registry to protect and promote early actions to reduce GHG emissions by organizations. Participation in this registry allows access to tools and consistent reporting formats which may aid in understanding the Region's GHG emissions and ways to reduce them.

GHG Emissions Reporting Protocol

For project-level GHG emissions assessments, GHG analysis shall use an emissions reporting protocol developed by the World Resources Institute (WRI) in cooperation with the World Business Council for Sustainable Development (WRI and WBCSD). This protocol was used as the basis for the CCAR. The WRI and CCAR emissions reporting protocols establish guidelines for voluntary accounting of GHG emissions and provide a peer reviewed and widely accepted methodology for calculating GHG emissions. WRI has also published several calculation tools to simplify and document the procedure, http://www.ghgprotocol.org/calculationtools/all-tools.
In general, the protocols outline how to estimate emissions from mobile combustion sources, electricity consumption, and industrial processes. Both the State and the federal government require reporting of emissions for regulated entities that emit 25,000 metric tons of CO2 or more per year.