October 8, 2020 Technical Peer Review Meeting
Handout #2

Public Utilities

Groundwater Sustainability Plan: Technical Peer Review

Preliminary Analysis of Climate Change Scenarios

Subject	Preliminary Analysis of Climate Change Scenarios	
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The purpose of this handout is to provide in advance of the October 8th Technical Peer Review (TPR) meeting some background information related to climate-change datasets for the San Pasqual Valley (SPV) area. The information provided herein has been processed by Jacobs Engineering Group, Inc. (Jacobs) on behalf of the SPV Groundwater Sustainability Agency (GSA). Included in this handout is a recommendation for the climate-change scenario that should be incorporated into the Groundwater Sustainability Plan (GSP) numerical integrated flow model (GSP Model) projections.

Background

GSP Regulations require the development of historical, current, and projected water budgets for the SPV Basin. Development of projected water budgets are required to incorporate assumptions regarding climate change over a 50-year planning period. The GSP Regulations do not prescribe a specific climate-change approach; however, the approach must be based on the best available science, be technically defensible, and be accepted by the California Department of Water Resources (DWR). In selecting a climate-change approach, it is important to consider the limitations and assumptions of each approach, the availability of data, and the ease of incorporating the data into the GSP Model framework.

Two climate-change approaches were considered for use in developing projected water budgets for the SPV GSP. The first approach is based on a “time-period” analysis, with which 50 years of historical monthly precipitation and reference evapotranspiration (ET) data are selected and prepared by the modeler and then processed through a DWR tool that adjusts these datasets to account for climate change.

The second approach is based on a “transient” analysis, with which projections from global climate models (GCMs) are used directly. These GCMs include projected climate conditions out to the year 2100 under a variety of climatic and greenhouse-gas-emission assumptions made by atmospheric scientists. As part of the California Fourth Climate Change Assessment (Pierce et al., 2018), a suite of 10 GCMs previously identified by the Climate Change Technical Advisory Group (CCTAG) (2015) was reduced to four GCMs representing warm/dry, average, and cool/wet conditions, and a complement (identified as a “diversity” scenario). Through this process, the following four GCMs were identified to represent potential climate variability in California:

- HadGEM2-ES (Warm/Dry)
- CanESM2 (Average)
- MIROC5 (Complement)
- CNRM-CM5 (Cool/Wet)

Each of these GCMs also considers Representative Concentration Pathway (RCP) scenarios that describe potential greenhouse-gas and aerosol-emission conditions. Two RCP scenarios have been analyzed with "RCP 4.5" representing a medium scenario in which a reduction in greenhouse gas emissions is considered, versus "RCP 8.5", which assumes a "business as usual" emissions scenario (Pierce et al., 2018). A recent study conducted by Schwalm et al. (2020) identified that the RCP 8.5 emissions scenario closely tracks historical total cumulative carbon dioxide emissions and is the best match for mid-century projections of greenhouse-gas emissions, based on current and stated policies. Thus, the Jacobs team has processed annual precipitation projections for the SPV area from the four GCMs identified by Pierce et al. (2018) with the RCP 8.5 emissions scenario to understand how these projections compare and to recommend one GCM as an appropriate climate-change scenario for the SPV GSP.

San Pasqual Valley Projected Precipitation

Monthly precipitation data for water year (WY) 2020 through WY 2100 from each of the four recommended GCMs were initially processed into average annual precipitation values across the SPV Model domain. For the purposes of the SPV GSP, the 50-year GSP planning period includes WY 2020 through WY 2069; thus, precipitation summaries presented herein span this 50-year time period.

Exhibit 1 presents the cumulative departure from the most recent 30-year normal (i.e., WY 1981 through 2010) mean annual precipitation (MAP) value of 14.4 inches for the GSP Model domain. Overall, the four GCMs indicate different outlooks as compared with the historical 30-year normal, especially toward the end of the 50-year GSP planning period. The CNRM-CM5 scenario indicates the most increase in precipitation over the GSP planning period with the CanESM2 reaching a similar level of departure by the end of the planning period. Conversely, the MIROC5 scenario shows the most decrease in precipitation over the GSP planning period. The annual precipitation associated with the HadGEM2-ES scenario remains relatively close to the historical 30-year normal precipitation (as evidenced by the cumulative departure of the HadGEM2-ES scenario being close to the zero line in Exhibit 1) until around 2060, when this scenario begins to show a declining trend.

Another important aspect to consider is the magnitude and timing of precipitation during a given year. Exhibit 2 presents the monthly average precipitation for each of the four GCMs during the GSP planning period, along with the monthly average precipitation values for the historical 30-year normal. The two "wetter" scenarios (i.e., CanESM2 and CNRM-CM5) show greater peak precipitation rates with earlier shifts in the timing of peak precipitation rates during the winter (see January and February peaks in Exhibit 2), as compared with rates associated with the MIROC5 and HadGEM2-ES scenarios.

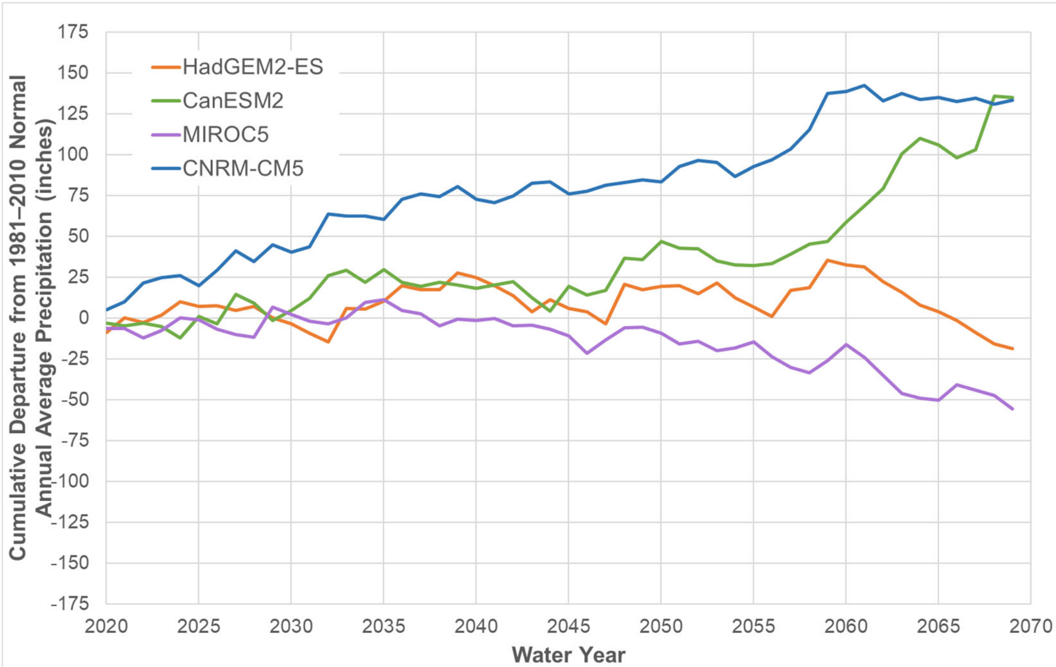

Exhibit 1. Cumulative Departure from the Historical 30-Year Normal Precipitation for the Four California-specific GCMs During the GSP Planning Period.

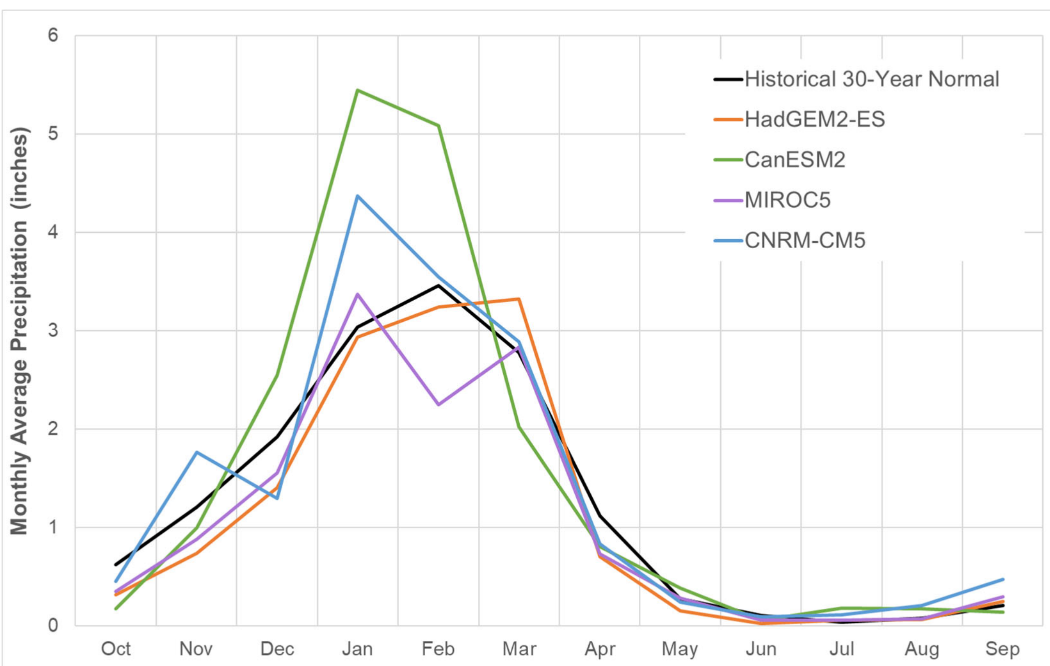

Exhibit 2. Monthly Average Precipitation from the Historical 30-Year Normal Precipitation for the Four California-specific GCMs During the GSP Planning Period.

Global Climate Model Recommendation

Table 1 lists some pros and cons associated with the time-period and transient approaches for incorporating climate change into GSP projections.

Table 1. Pros and Cons of Climate Change Approaches.

Analysis Approach	Pros	Cons
Time-period (via the DWR tool)	• The tool to perturb historical precipitation and reference ET values to incorporate climate change conditions is a DWR product and therefore would be readily endorsed by DWR.	• A 50-year baseline set of precipitation and reference ET data would need to be assembled by the modeling team. • Selection of a 50-year baseline set of historical precipitation and reference ET data would be subjective and not necessarily provide the best available climate projections for the SPV area. • A method would need to be developed to, at each GSP Model stream inflow point, project monthly inflows that would result from the projected precipitation and reference ET values that incorporate climate change.
Transient (via GCMs and the Basin Characterization Model [BCM])	• GCM data have been generated by atmospheric scientists using the best available science and are therefore, technically defensible. These GCMs are the same GCMs that DWR used to develop its "time-period" analysis approach with its climate-change tool. As such, using these GCM data will be endorsed by DWR. • Does not require the modeling team to assemble any historical climate data to develop future climate data. • The BCM has already been used by U.S. Geological Survey (USGS) experts to simulate runoff for the four GCM scenarios. Thus, the modeling team would not need to independently develop a method for computing stream inflows to the GSP Model domain under climate-change conditions. • Bias-corrected BCM runoff values developed for the contributing watersheds using historical streamflow data can be applied to BCM projections of the selected GCM (see Handout 4a). • Using bias-corrected BCM runoff values for projected stream inflows is easy to incorporate into the existing GSP Model framework.	• The perception that the approach would not be using DWR's available tool to incorporate climate change into GSP projections and therefore takes on unnecessary risk of DWR not endorsing the GCM approach. Although, the likelihood of DWR not accepting this approach would be very low.

Based on the pros and cons listed in Table 1 and the analysis of projected precipitation data presented herein, the modeling team recommends using the HadGEM2-ES, RCP 8.5 scenario (Exhibit 3) to develop projected water budgets for the 50-year GSP planning period. This dataset assumes “business as usual” greenhouse gas emissions and climatic conditions that plot within the range of the ensemble, but on the drier side of the four California-specific GCMs. If during the GSP implementation an additional GCM would be of interest, the modeling team would recommend using the MIROC5 RCP 8.5 scenario as a “stress test” projection of potential future water budgets.

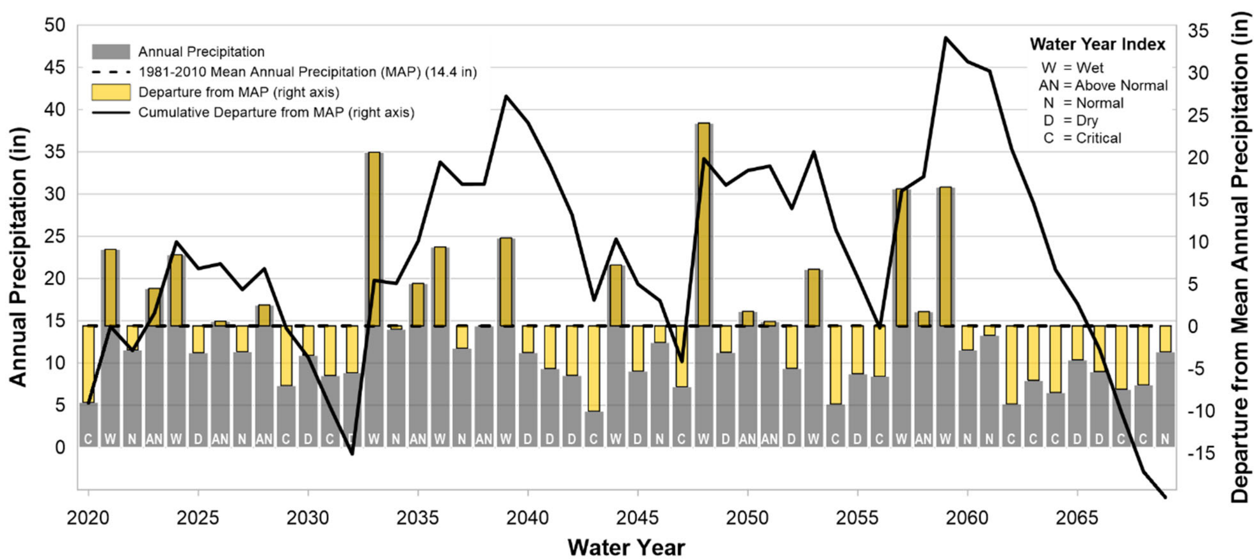

Exhibit 3. Projected Precipitation and Cumulative Departure from the Historical 30-Year Normal Precipitation Under HadGEM2-ES, RCP 8.5 Conditions During the GSP Planning Period.

References

California DWR Climate Change Technical Advisory Group (CCTAG), 2015. Perspectives and guidance for climate change analysis. California Department of Water Resources Technical Information Record, 142 p. (https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/Climate-Change-Program/Climate-Program-Activities/Files/Reports/Perspectives-Guidance-Climate-Change-Analysis.pdf)

Pierce, D.W., J.F. Kalansky, and D.R. Cayan, 2018. Climate, Drought, and Sea Level Rise Scenarios for the Fourth California Climate Assessment. Scripps Institution of Oceanography, California’s Fourth Climate Change Assessment, California Energy Commission. Publication Number: CNRA-CEC-2018-006.

Schwalm, C.R., S.Glendon, and P.Duffy, 2020. RCP8. 5 tracks cumulative CO2 emissions. Proceedings of the National Academy of Sciences 117.33: 19656-19657.